THE

ELECTRICAL REVIEW.

VOL. XLI. JULY 23, 1897. No. 1,026.

CONTENTS:

	PAGE
Distributing Systems	101
Recent Progress in Arc Lighting (*concluded*)	103
Smith and Granville's Telephone Cable (*illustrated*)	104
Electric Power Transmission at Fresno (*concluded*)	105
The Galloway Boiler	108
The Working of Long Submarine Cables (*concluded*)	108
Cassel Gold Company	112
Review:—Electro-Métallurgie	112
Correspondence:—	
Regulating Boosters	113
The New Earthing Device	113
Commutator Bars	113
Legal:—	
British Aluminium Company *v.* Armstrong, Mitchell & Co.	113
Yell *v.* Rounds Accumulator Company	113
Business Notices, &c.	113
Electric Lighting Notes	115
Electric Traction and Motive Power Notes	116
Three-Phase Power and Light Plant at Liverpool (*illustrated*)	117
Telegraph and Telephone Notes	122
Contracts Open and Closed	122
Notes	123
City Notes	126
Traffic Receipts	128
Share List of Electrical Companies	129
Electric Motors in the Northern Pacific R.R. Shops	130
The Municipal Electrical Association, 1897 (*illustrated*) (*continued*)	131
The Lighting of the Embankment	135
The Production of Steam	135
New Patents and Abstracts of Published Specifications	136

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DISTRIBUTING SYSTEMS.

OF the two papers bearing the above title, which were read at the meeting of Municipal Engineers, and which we reprint on another page, that by Mr. Blaikie deals chiefly with lead-sheathed cables and transformer chambers, whilst Mr. Jeckell's paper discusses in general terms the advantages and disadvantages of high and low pressure, and continuous and alternating currents.

Mr. Blaikie, after lamenting that the Board of Trade does not allow the use of aerial lines, briefly mentions several systems of underground mains, and when speaking of their historical development, says: "The first stage appears to be conductors strained from point to point on insulators in culverts." We do not know to what instance of their use he refers; but we believe that both rubber and fibrous lead covered cables can claim priority of bare wires in culverts. He then states that the most popular solid system is the lead sheathed armoured cable used in some form or other in at least 56 undertakings in Great Britain, and says that there can be but little doubt as to the reliability and cheapness of a system so largely adopted. To prove his point Mr. Blaikie presents a table compiled from data published by a contemporary, we presume, in its sheet supplement of central stations. This table would have been very valuable if it had been accurate; but it appears to have been compiled with very little care, as in three of the five columns the figures quoted do not add up to the totals given at the bottom of the columns.

On referring to our contemporary's supplement we found that the total of 56 for lead covered cables of all kinds was about correct, but we made the total of stations using rubber cables about 50 per cent. greater than that given by Mr. Blaikie. Again, one would imagine from a perusal of the paper that the cables of the Callender Company were only in use in eight cases, as only the solid system is spoken of separately; whereas we found nearly 30 stations mentioned by our contemporary where bitumen was given as the insulating material. We do not wish to advocate or to condemn any particular class of cable or method of laying, but only to point out that the way in which this table has been compiled renders it comparatively useless; and to suggest that a more useful comparison could have been made by dividing insulated cables into two types, viz., those that depend on the lead sheathing for the exclusion of moisture and those which are insulated with a waterproof material; and then by comparing the two methods of laying, viz., the solid system and the drawing in system.

The latter part of Mr. Blaikie's paper contains much useful information about the construction of transformer chambers, the cost of the same, and methods of preventing sweating of the roof; and it concludes with some suggestions in favour of greater uniformity of size in distributing cables—suggestions which manufacturers would, we

imagine, be glad to see adopted if there are many stations like one mentioned by Mr. Blaikie, where no less than fifteen different sizes are in use.

Mr. Jeckell's paper deals with the subject in a more general fashion, and commences by enumerating various reasons for having the very best distributing plant procurable, even although it may not be the cheapest. He then discusses, in general terms, the advantages and disadvantages of low and high tension systems, giving the preference to low tension whenever the distances are not too great, on account of the greater facilities for improving the load factor; and when transformers must be used, to a system in which transformers of moderate size are placed direct in the ground, and not in transformer chambers, owing to the great flexibility of this system.

Passing on to speak of mains, Mr. Jeckell expressly states that he has no intention of making comparisons between various kinds of cables, and advocates suspending judgment, and that engineers should not too hastily condemn material which, when the full circumstances of the case are known, may be found not to have been so bad after all. His reason for this advice is apparently that he lays much stress on the importance of careful laying of the cables; and having had experience of nearly every type of cable, has come to the conclusion that many faults which are put down to faulty manufacture, are really due to bad laying, and that it is quite possible that a good cable badly laid may be worse than a bad cable well laid.

Learning to Labour.

THE labour question presents, at this moment, some vivid contrasts. We have before us the lamentable spectacle of over 20,000 men shirking their duty, warring against their own and their country's best interests, making an untenable claim for an eight-hour's day they do not want, as a possible means for obtaining an unreasonable wage. It is a pleasure, at such a time, to turn from the reports of labour federations and strike committees, and to note the improvements lately brought about in technical arts, and trade methods, by the City Guilds' Institute and allied classes. Here, at any rate, we find the true spirit of patriotism; it is manifested in a vast scheme for protecting British interests and raising the tone of labour, not by seditious strikes and intimidations, but by converting the workers into intelligent and directed craftsmen. Such classes, founded, governed, and maintained by the masters, are producing a better condition of labour, a happier class of workpeople; and whatever differences may arise in the future between the employer and employed, this effort on the part of the masters towards the improvement and comfort of their men deserves to be remembered. Private differences must be settled by law, otherwise labour, as brute force, conquers and destroys everything. We have every sympathy with the efficient, under-paid, worker, but whether he be an engineers' fitter, a telegraphist, or a soldier, he is equally unjustified in mutiny. He must stick to his guns, and "learn to labour and to wait." From figures given by Mr. S. H. Wells, in the *Journal* of the Society of Arts, we find that during the 10 years prior to 1896 the number of separate classes registered by the City and Guilds of London Institute increased from 262 to 1,120. Last year the registered number of students was nearly 27,000, in 68 subjects, of which 63 are directly connected with important practical industries. There is some amount of difficulty in providing efficient teachers, but the care that has been taken in this respect has been well repaid by the high standard of efficiency attained by the students. No less cheering is the evidence of Prof. Ayrton as to the appointments secured by those who pass through this training. Speaking with special reference to students of the Central Technical College, he assured the Congress that every intelligent student who goes through the complete diploma course secures remunerative employment within a comparatively short time. Prof. Ayrton desires to see improvement in the co-ordination of teaching, especially in London. The power of giving instruction in our City is great, facilities for obtaining this instruction are increasing day by day, but there is no generalship, no unity of purpose between the colleges. Prof. S. P. Thompson emphasised the necessity for some such scheme, and pointed out that the great difficulty in the way of co-ordination is geographical, it is a question of transferring students from college to college in a reasonable time. We fail to realise this as a serious difficulty; it does not take half a day to travel from Finsbury to Kensington, although the electric railway does not get any nearer than it can help to the Central Technical College. The suggestion of co-ordinating the teaching powers of London, is worthy of a Royal Commission; the system might easily be extended to include organised instruction in the factories and arsenals themselves—a scheme that the ELECTRICAL REVIEW has long advocated.

The Operation of High Pressure Steam Plant.

IN conversation recently with a well-known American engineer, he informed us that in many of the large buildings in America the demand for warmth is so great during a large part of the year that it has ceased to be a matter of much concern to use very economical engines in the basement for operating the lighting plant. The exhaust steam is all used up, and a double exhaust pipe is employed so that when all the exhaust is not wanted in the heaters it can be discharged directly to the atmosphere. Writing in the *Street Railway Review*, Mr. F. L. Ray considers that for a heating system to pay the plant should be close to the centre of distribution, while to make condensing pay, water must be close to hand. He advocates the return of the water from the heating coils to the boiler. For 200 lbs. pressure, there must be no cast-iron fittings unless extra heavy and all fittings above 3 inches should be flanged—not screwed—and faced, and jointing material should be such as will soften when hot, and let the flanges come together, almost iron to iron. Thick jointing will very likely blow out. Oil and graphite is recommended for all faces and bolts. It prevents sticking and rusting. The statement is made that there are no valves to-day that can be opened without injury without a small byepass at 200 lbs. Gate valves should have movable seats so driven in as to be removable for repairs. Globe valve seats also should be driven, not screwed. Steel valve spindles are recommended and will not rust with proper application of graphite. The stem ought to be capable of packing regardless of the valve being open or shut. High pressure will not tolerate discs of soft metal or rubber. They will render it impossible sometimes to shut off steam. Bronze valves and seat are the best. Brass body valves are as a rule undesirable; they are too light because of expense, and they twist out of shape and leak. They would be all right if only heavy enough. Blow out valves especially will run tons of coal to the sewer if out of order. All water of condensation should return to the boiler. There is no water gauge glass suitable for 200 lbs. They will sometimes last a week or two. In any case, they must be short and to-day the self-closing chain-pull gauge cock is the best practice, and these soon wear out if much used. The author doubts if even 200 lbs. is the limit of practice in steam pressure and looks forward to improvements in details that will enable still greater pressures to be employed. Direct driving is putting belt driving to one side. Vertical engines require much less oil than other types. Direct connected engines must be carefully insulated from each other when arc lighting or on street railway work with 4,000 to 6,000 volts. The floor must be such that if the machine be grounded no harm can come to the attendant if he touch it, but extra precautions such as rubber mats should be taken. Raw hide forms a good flexible coupling next to wood or fibre. High pressure plant has come to stay, and, needless to say, it must be carefully attended if the full benefit of high pressure and expansion is to be secured.

RECENT PROGRESS IN ARC LIGHTING.*

By ELIHU THOMSON.

(*Concluded from page* 95.)

The mechanism of an inclosed arc lamp to be run singly in branches from 110-volt circuits is naturally very simple. Since the lamp regulates entirely by variations of current on its circuit, a simple series magnet suffices. No cut-out other than a fuse in the lamp branch is needed.

The switch is a plain open-circuiting switch. A choking resistance is mounted on the lamp or elsewhere in the branch, the drop over which is about 30 volts. The upper carbon or its holding rod is acted on by a simple positive clutch. There is required, however, even in such a lamp, so apparently simple in itself, great care in proportioning the parts and their relative actions, to secure the best results. If the constructor fails in any detail, the behaviour of the lamp soon tells the story—the current is interrupted frequently; the voltage around the arc varies greatly; the current, as well as the light of the lamp, varies.

The running of single alternating current arc lamps on constant potential circuits is facilitated by the ease with which, by a transformer or compensator, the potential required for the lamp may be obtained.

An alternating arc is peculiar, and different from the continuous current arc in a number of important particulars. The fact that the arc is extinguished between successive alternations at the zero points of the current wave, and at a rate equal to double the periodicity, results in the musical sound of the arc, which may become a source of annoyance. The same cause gives rise to difficulty in starting the arcs without having them chatter, for until the carbons get strongly heated the arc is not re-established after extinguishment with the carbons separated. With cold carbons, the carbons must touch each other after an extinguishment at the zeros. Hence the carbons must be separated very slowly, while a large current flows so as to strongly heat their ends, or a higher potential than that to be used in running the lamp after starting must be applied at first. Another way is to employ a resistance, or, better, a reactive coil in circuit with the arc lamp, so as to change the character of the potential at the lamp terminals, which then becomes less than that of a constant potential, and, in fact, begins to approach, in a measure, constant current supply. But in the use of a resistance or reactance in circuit with the lamp, it is, of course, necessary to increase the potential of the line accordingly, so as to give the proper potential to the arc; while both expedients involve a loss of energy. It is found not to be practicable to run alternating arc lamps on circuits much below 40 cycles; the common rates of 60 and 125 are well adapted to the case.

The efficiency of the alternating arc as a source of light has been shown by Prof. A. E. Blondel, in a recent paper, to be quite variable. It depends on the length of arc used with the particular carbons employed, and on the diameter of the carbons, as with continuous current. It also depends on the form of the wave of the alternating current. It was found that, with a rectangular wave alternating current, such as may be produced by reversing a continuous current by a commutator, the light given out was as 79 to 59 in the case of sine wave currents. This should follow from the fact that the extinctions, as Blondel pointed out, were instantaneous in the first case, and lasted for about one-quarter of an alternation in the case of the sine wave.

The writer takes the occasion to express the opinion that, with very flat-topped waves, or waves approaching closely to rectangular waves, the limit of periodicity would be found far below 40 per second, as regards the maintenance of an arc. If the reversal or passage through zero is quick enough, almost any reduction of periodicity would become possible. There are, however, practical considerations which set the limits in such a case.

Soft carbons, or those best suited to readily furnish considerable volatile matter, seem to be best adapted to alternating current arcs, and they are frequently cored. The colour of the light suffers some in consequence.

The use of single arcs across alternating, constant potential mains, requires only that the lamp mechanism be operated by variations of the current passing the arc. Hence, an electro-magnet in series is used to lift and feed the carbons, or sometimes the expansion of a high resistance wire, traversed by the lamp current, has been applied for the same purpose, as in the "Kester" lamp. The electro-magnet is open to the objection that its action is so instantaneous as to be liable to provoke chattering at starting, requiring a carefully adjusted check, or dash-pot, to prevent such action, and the magnet armature, or core, may also, unless very carefully arranged, produce by its inevitable vibrations a harsh note audible some distance away. Add this to the hum of the arc itself, and it is easy to see that such a lamp may become intolerable indoors in a quiet room. In the use of a hot wire the objection of chattering at the start is overcome without difficulty, and the wire is noiseless in its action; but it demands that considerable energy be wasted in it. If the arc requires 28 to 30 volts, and the regulating wire 5 to 7 volts, it is easy to see that a considerable sacrifice has been made for the result attained, particularly as in the use of hot wire over-feeding is liable to take place. The writer obtained, a considerable time ago, a much better result by using the hot-wire principle, but variably shunting it by a set of contacts controlled by a small electro-magnet in series relation, which addition imparted greatly increased sensitiveness, while the slow start given by the hot wire was still secured.

The arc in the ordinary alternating current arc lamp appears to be stable, even when the connection is made across constant potential mains without resistance or reactance in the branch as a check upon the current. Therefore, nearly all the energy may be thus delivered to the arc itself without deduction. This fact tends to neutralise the lower efficiency of light production in the alternating arc, since the continuous current arc on constant potentials involves a dead resistance loss. Any comparison, then, must for practical purposes consider the total energy used in the branch in which the lamp exists, and the light produced or emitted in directions permitting utilisation.

While the alternating arc run from constant potentials is feasible, the difficulty of chattering and large variations of current at starting result from the arrangement, and any sudden fall of potential may cause a momentary extinguishment. Particularly is this the case when the arc is of the "enclosed," long-burning type. In such case, on account of the greater length of the arc, it is peculiarly sensitive to influences which would affect but slightly the ordinary open-air arc. With the open-air arc a comprehensive set of tests made under the writer's supervision disclosed the fact that various makes of carbon gave widely different results. It was found that the length of arc or separation of the carbons for a given potential was, under equivalent conditions, quite variable, and the curious fact was noted that with some makes of carbon the variation of arc length with variations in the potential of the circuit supplying the lamp were much less than with certain other makes. Some gave excessive variation of arc length with moderate variations of potential at the arc, while others gave only moderate variations of arc length for considerable variation of potential at the arc. Of course, the latter are far the most desirable carbons for practical use. The results in each case were plotted as a curve, and comparison and superposition of the curves showed the superiority of one or another brand. The curves showed also the arc length for each kind of carbons for a given potential across the arc, which it was important to know in selecting carbons best adapted for alternating current work. The carbon which gave the longest arc at the lowest potential, and one which did not vary its length as much or more than that obtained with other carbons for certain variations of potential, would practically be preferred, other things being equal. It is too early to predict what part the "enclosed" alternating arc may play in the future art of arc lighting, but it probably will find a considerable application.

The larger the arc, or the larger the current in it with a normal voltage, the more efficient is the light production. Measurement shows that where, with continuous current, the same brand of hard carbons is used of diameters varying approximately with the current strength, naked arcs, with 10 amperes and 48 volts, may take for each mean spherical candle-power 1·2 watt, while arcs of 7 amperes and 48 volts require 1·4 watt.

Measurements show, after a run of 102 hours, and per

* Abstract of paper read at Convention of the National Electric Light Association, at Niagara Falls, June, 1897.

each mean spherical candle-power of a $4\frac{3}{4}$ ampere, inclosed, continuous current arc with clear inner and no outer globe ($\frac{1}{2}$-inch carbons), an expenditure of 1·94 watt at the arc. While it may seem that the watts per candle are higher than might be expected, yet it must be borne in mind that, in all inclosed arcs, the current is relatively small and the potential high for a given expenditure of energy, and this acts in a double way to lower the efficiency, as not only the crater emitting light is smaller, but a large part of the energy goes to sustain the arc flame, which is long, while also the absorption of light by the surrounding glass is not to be neglected. No construction of lamp, regulation, or adjustment thereof can get rid of the inherent properties here pointed out. Nevertheless, it is true that the character of the light, both of the open or exposed arc and of the enclosed arc, is such as to make it very desirable as a substitute for daylight, and for many cases of use. The fact that the light is shed mainly downward by continuous current arcs results virtually in an addition to the efficiency and economy of the light; thus, if the light emitted downward be considered as alone useful, the expenditure per mean useful candle would, with naked arcs, fall to about one-half a watt, and with inclosed arcs to from one to one and one-half watt at the arc.

With alternating arcs the conditions are different, since the light is sent up and down equally. By a reflector placed above the arc a considerable fraction of the light which would often be lost upward is sent downward to increase the effectiveness; thus a 16-ampere, 25-volt naked alternating current arc used, per mean spherical candle, 1·49 watt, or for mean useful below the horizontal, 1·12 watt, which was reduced to ·8 to ·9 watt when a porcelain reflector above the arc was used. For the same causes that necessarily reduce the efficiency of an enclosed, continuous current arc, as compared with the unenclosed, the efficiency of an enclosed alternating arc falls below that of the open arc with similar currents. The watts at arc per candle will be found, per mean spherical candle, to be, under the best conditions, about 2 watts, increasing toward the end of the run, owing to obscuration of the inner globe and other causes. No reflector or deflector can be used with much effect with the enclosed arc, so that the mean useful is but little different from the mean spherical candle-power.

The apparent advantage in economy of the continuous current enclosed arc over that with alternating currents is in large measure neutralised by the fact of the former requiring a dead resistance in circuit to give stability to the current, while the latter can be run without it, or, at most, with a reactive coil, which wastes but little energy.

Still, it must be confessed at the end that the luminous yield is but little better than that obtained in incandescent lighting. After all, it may be that the whiteness of the light and the daylight effect obtained may be a sufficient reason for the large introduction of enclosed arcs, now that the frequent trimming and attention to the lamp is not needed. Indeed, it may also appear that all the varieties of arc lighting which have grown into importance within the past few years have their own fields of usefulness, and that, therefore, the work spent in developing them has not been labour in vain.

It should be said, in conclusion, that the figures given above, and expressing the watts per mean spherical candle, while strictly comparative so far as a study of arc lights alone is concerned, might vary somewhat if the object had been to compare arc and incandescent lights, owing to the difference in colour of light, though the variation would not in any case be great.

SMITH AND GRANVILLE'S TELEPHONE CABLE.

On June 30th H.M.T.S. *Monarch* laid a submarine cable between Beaulieu, in Hampshire, and Gurnard Bay, Isle of Wight, a distance of 1·94 nautical miles, in connection with a new telephone line in course of construction between Southampton and Newport.

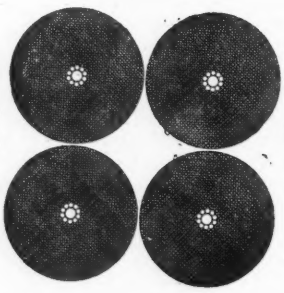
This cable, which was manufactured by the Telegraph Construction and Maintenance Company, in accordance with Messrs. Willoughby Smith and W. P. Granville's patents, is of great interest and importance, inasmuch as it contains the first practical deviation from the form of core now in use—a form originally adopted in the earliest days of submarine telegraphy.

The new form of core, which we illustrated last week from a piece of the actual cable, consists of four conductors insulated from one another with gutta-percha, and the component parts are of such a section and so symmetrically twisted together, that a longitudinal air space is formed thereby, and then the whole is finally covered with gutta-percha.

Short lengths of this "air space" core have been subjected to a hydraulic pressure of 700 lbs. per square inch, without any sign of damage or alteration in shape, and the electrical tests show results which are highly satisfactory. The advantages of this form of cable will become apparent by referring to the above illustrations and figures.

Tests taken since laying the cable give excellent telephonic results, with perfect freedom from "cross-talk" and external induction.

Diagrams Showing Actual Size of Cores.

		Total weights.		K.R. per knot closed circuit.
Section of cores of the London-Paris telephone cable.		640 lbs. copper wire. 1,200 lbs. gutta-percha.	Copper resistance 7·48 ohms per knot. Inductive capacity between diagonal wires ·1385 mfds. per knot.	2·0719
Willoughby Smith and W. P. Granville's new air space core.		940 lbs. copper wire. 940 lbs. gutta-percha.	Copper resistance 5·163 ohms per knot. Inductive capacity between diagonal wires ·098 mfds. per knot.	1·012
Section of cores required to give copper resistance and inductive capacity approximately similar to that of the new air space core.		940 lbs. copper wire. 5,100 lbs. gutta-percha.	Copper resistance 5·163 ohms per knot. Inductive capacity between diagonal wires ·108 mfds. per knot.	1·115

The inductive capacity of the laid cable is ·095 microfarads per nautical mile between the diagonal wires, but the length, 1·94 nautical miles, is too short to show the advantage, if any, to be obtained by the close proximity of the conductors without water intervening.

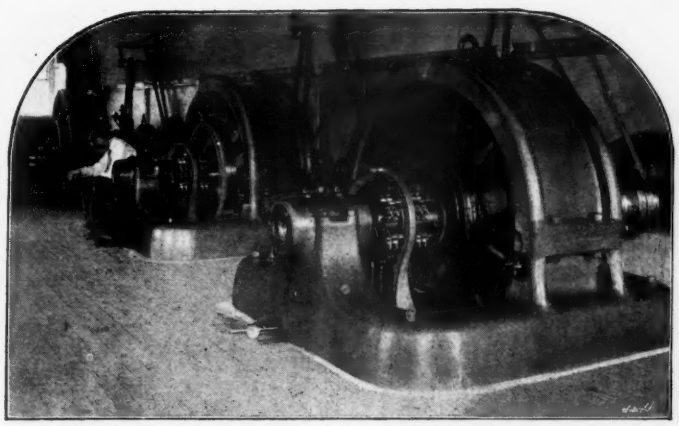
If the vexed question of leakage should ever be settled in favour of the leak, then the air space will prove of additional value as a conduit for containing the inserted resistances.

ELECTRIC POWER TRANSMISSION AT FRESNO, CALIFORNIA.

(*Concluded from page* 79.)

The Power House.

The power house is a model of central station architecture; it is 76 feet long by 36 feet in width, and is of granite. Within it are three kilowatt multipolar general electric three-phase generators, delivering current at 700 volts and 60 cycles per second to the low potential switchboard, whence it is carried to the bank of nine 125 kilowatt transformers, delivering three-phase current to the line at 11,200 volts through the high potential switchboard. In addition the station carries two 12½ kw. multipolar exciters, each being of sufficient capacity for the operation of the entire plant.



View of 350-kw. Generators at the Power House.

Power House of San Joaquin Electric Company.

The power house and sub-station are protected by Wirt lightning arresters and choke coils. Each transmission line on entering the station is taken through a choking coil, consisting of 150 feet of the same size of wire as used in the line. In the present instance, No. 3 B. & S. copper wire, covered with weather proof insulation, is coiled into a ring 15 inches in diameter, the whole ring being then well taped. From the coil the high potential circuit is carried to the high potential switchboard, and thence to the step down transformers. At ordinary periodicities such as 60 cycles per second, as used in the Fresno plant, the self-induction of these rings is inappreciable; but at the enormous frequencies of a lightning stroke the coils prove effective in protecting the apparatus beyond them, and in forcing the lightning to take the path to earth provided through the lightning arresters. Each of the transmission lines is provided with a lightning arrester, and these consist of 40 non-arcing metal cylinders screwed to a marble base, and hence removable, the surface of each being separated $\frac{1}{32}$nd of an inch from that of the adjoining cylinder. The ground discharge from the bottom of the arrester is carried to earth by a copper ribbon, 1 inch in width × $\frac{1}{32}$nd of an inch in thickness. Similar rings with suitable arresters are also placed on the 200-volt and 1,000-volt circuits extending from the sub-station.

The Pole Line.

The entire pole line, whether on the mountains or over plains, is constructed of square sawed redwood poles, 12 inches × 12 inches at the butt and 6 inches × 6 inches at the top, the length varying from 35 to 40 feet according to locality. On the plains the poles are set 120 feet apart, while on the mountains the separation varies according to the contour, but approximates 100 feet. Standard six-pin 7-foot cross arms are used. These are placed 20¾ inches apart, and the pole lines for the transmission proper carry two such cross arms for the transmission circuits, and one additional 48-inch cross arm for the telephone service, the latter being 62½ inches below the lower high tension cross arm. Certain portions of the pole line are equipped with a third cross arm for carrying the line and circuits of the company.

The poles were hauled and erected by the San Joaquin Electric Company, and the task was beset with difficulties owing to the mountainous country and the frequent blasting necessary in digging holes. Throughout some portions of the route a 20-foot clearance has been cut, as have all trees that could by any possibility fall across the circuit. In addition to this clearing the San Joaquin Company constructed a waggon road 4½ miles long, and a bridge having a 100-foot span and 340 feet of approaches.

The transmission circuits consist of two triphase three-wire sets which may be used independently, or together as desired. All wires are of No. 3 Browne and Sharp, soft drawn copper. These two sets are divided by the pole, and the top cross arm supports the wires of each set; the third wire being immediately below. The lines are arranged so as to form an equilateral triangle, having 24 inches on a side, and the main line is transposed every 40 poles, or approximately every mile. Standard triple petticoat porcelain insulators are used, and the method of tying is peculiar. A No. 8 soft copper wire is used. This is about 20 inches in length, and in placing the line wire in the top groove the tie wire is placed with it, and its ends carried around the insulator groove in the same direction, each making a complete circle before being wrapped.

The results obtained from the telephone circuit carried over this pole line are truly marvellous. Hunning's dust transmitters of a type that do not infringe the patents of the American Bell Telephone Company are used over a circuit of No. 14 hard drawn copper wire supported by porcelain knobs. The telephone circuit is transposed at every fifth

pole through the use of Locke's transposition, and the line is absolutely quiet, despite the fact that its length is 35 miles, and that the initial potential is 11,200 volts.

The high potential switchboard at the sub-station at Fresno is not accessible, and the switches are thrown by the use of a long bamboo pole with a ring on the end. It is difficult to measure the length of the arc drawn out on throwing the switches, but even in full load it does not

Pole Line near Fresno City.

appear to be in excess of one half an inch. The high potential switchboard affords the means for throwing any of the various types of step-down transformers on either one or both of the sets of transmission lines. These step-down transformers are all of the air blast type, and are divided into three sets, each designed for a separate purpose. Three 125 kw. transformers deliver current at 115 volts to the 3-wire incandescent circuits. The second set consisting of three 75 kilowatt transformers deliver current at 1,000 volts for operating power circuits through the use of induction motors and for the high tension lighting districts. The third set consisting of three 40 kilowatt transformers delivers current at 1,000 volts for the County Hospital and other outlying districts. A 5 H.P. induction motor drives a Sturtevant blower for the cooling of the transformers, and the fact that this motor is belted to the blower forms the only inharmonious feature in the equipment of the sub-station, there being no other belts used.

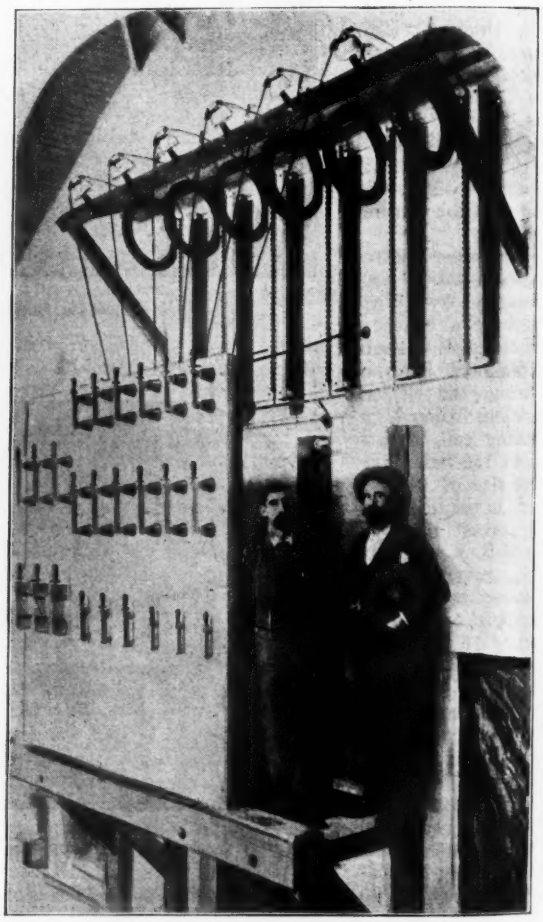
From these transformers the current is carried to the low potential board. Of these, five panels are for controlling the low potential incandescent and power service. One panel controls the 1,000 volts hospital circuit, one controls the Chinatown 1,000 volt incandescent service, two panels control the 1,000 volt mains for the outlying residence lighting, and the last panel controls the induction motors driving the Brush arc light machines. Each of these arc lighting sets consists of a three-phase induction motor direct coupled to an 80 lamp 2,000 candle-power Brush arc lighting dynamo, run at 700 revolutions per minute. A special switchboard for the arc lighting service is of one panel carrying six circuits and provided with two Weston ammeters and four-type "A" Thomson-Houston lightning arresters, together with the usual accompaniment of spring jacks and the different equipment of the new regulator Brush "Z" type dynamos. The 1,000 volt power service is taken direct from the transformer to the line and the Chinatown service is rendered through a special 1,000 volt transmission to Chinatown, where step-down transformers reduce the potential to 115 volts for distribution on the four-wire system.

The entire business section of the town has been wired up uniformly with the four-wire system. No. 0000 B. and S. bare copper wires are used almost exclusively as feeders, and are so arranged that wires to the south and west of pole lines are neutral wires, and those adjacent thereto are the "A" "B" "C" wires respectively in the order of their sequence.

The regulation of all circuits, whether for power or incandescent service is effected through potential regulators introduced into each outgoing circuit by means of which the voltage is regulated at centres of distribution.

Rates of Service.

A surprising feature in connection with the San Joaquin Electric Company is the remarkably low rate at which electric service is rendered. The company has secured the



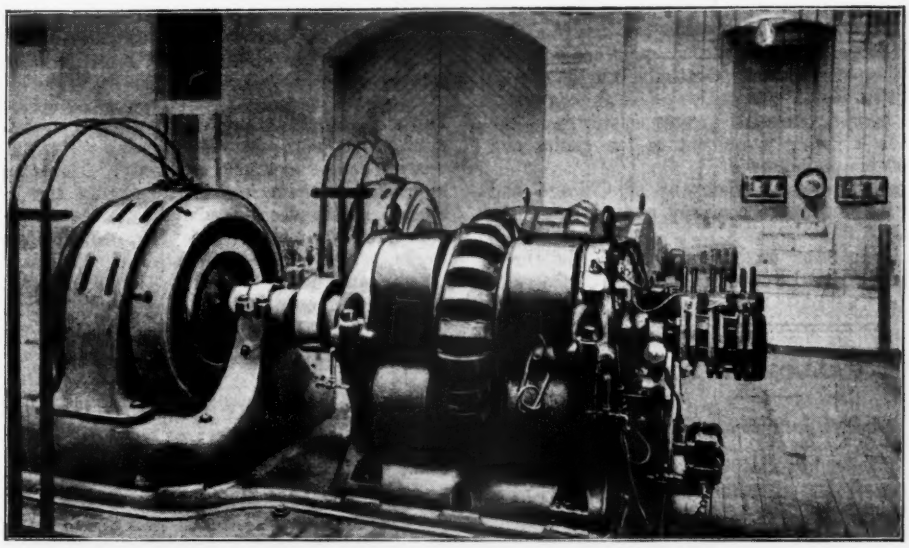
High Tension Switchboard in Sub-station.

municipal lighting contract for lighting the city of Fresno with 2,000 C.P. arc lamps at the rate of $6.45 per month per lamp, all night and every night. Electric power is delivered approximately at the rate of $64.00 per H.P. per year 24-hour service, and incandescent service is rendered by meter rates or flat rates. The rate for meter service is 15 cents per kilowatt per hour, with discounts varying from

5 per cent. to 25 per cent. according to consumption. In residence lighting flat rates prevail exclusively, and the novel system has been inaugurated of charging for service according to the location of the lamp at the following rates per month:—

Sitting room, 30 cents per 16 C.P. lamp per month.

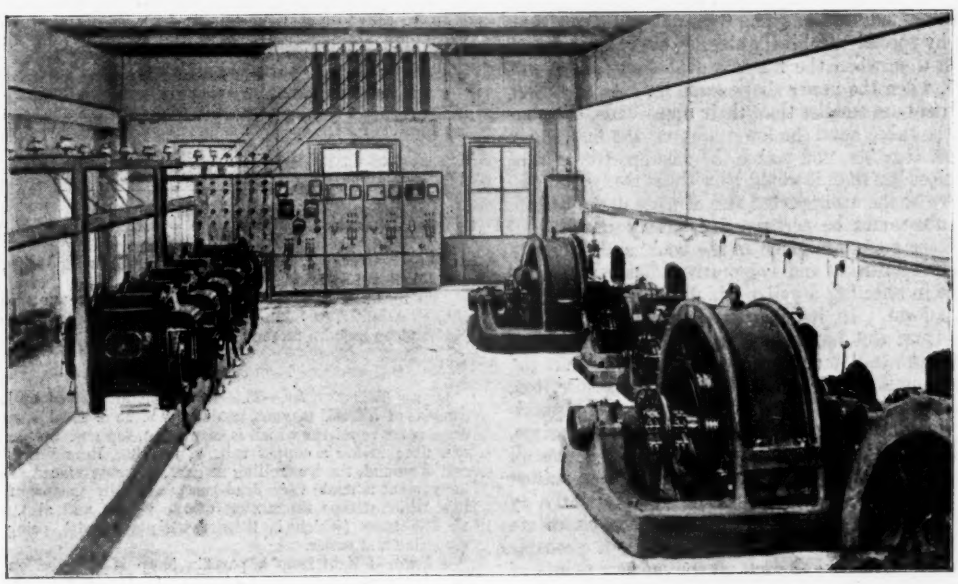
Halls, dining room, or kitchens, 25 cents per 16 C.P. lamp per month.



Combined 80-Light Brush Arc Machine and 60-H.P. Induction Motor.

Parlours, pantries, and barns, 15 cents per lamp per month.

Bed and bath rooms, cellar, garret, 10 cents per lamp per month.



Interior of Power House—General View.

The very favourable rates which have been established by the San Joaquin Electric Company for power service have already brought it several large contracts, principally among which is that of the Sperry Flour Mills, which is being operated by a 150 kilowatt synchronous motor running at 600 revolutions per minute. The city water works is also running by electric power, and a 75 kilowatt induction motor belted to a Root rotary pump, of a capacity of 3,000,000 gallons has been installed. This latest equipment will displace a 4,000,000 gallon total expansion Holly steam pump, now used. At the present time the company is furnishing 5,800 incandescent lamps and 170 arc lamps of 2,000 C.P., 72 of the arc lamps furnished to the city, the remainder being commercial and county.

A novel feature is the lighting of the County Court House and grounds. Eight arc lamps are hung at the lantern of the tower 150 feet above the street, and form a beautiful light for the streets about the building. The 15-acre park contains 56 20-C.P. incandescent lamps arranged on brackets along the walks, giving a beautiful effect. The company has at present 550 H.P. of motors on its power service, and contemplates many extensions in the near future.

Promoters of the Enterprise.

The conception of the plant of the San Joaquin Electric Company is due to Mr. J. S. Eastwood, civil engineer of Fresno, who had long been impressed with the magnitude of the water there available, and as soon as the feasibility of

electric transmission over long distances had been commercially assured, he began the organisation of a company for the purpose of developing water power and transmitting its energy to Fresno. Fresno offered a particularly favourable field for the introduction of electric light and power, because of the high price of fuel, and the fact that the influences of the lighting interests theretofore existing had been bent in the direction of restricting the means of lighting to the use of gas and arc lamps. As a result of Mr. Eastwood's efforts, Mr. J. J. Seymour, president of the Fresno Water Company, became interested in the enterprise, and they soon organised the San Joaquin Electric Company. This was accomplished on April 2nd, 1893, and the plant is now practically completed. It would be difficult to find a proposition of such magnitude which has been carried out with greater celerity, and the installation stands a fitting monument to the genius and energy of Californian promoters.

The Municipal Investment Company of Chicago and London took an interest in the company, and advanced the necessary capital.

The electrical apparatus used throughout is the three-phase type of the General Electric Company.

THE GALLOWAY BOILER.

In a small book entitled "Boilers, Engines and Machinery," published by Messrs. Galloways, Limited, of Manchester, we find the Galloway boiler historically described. If we are to judge by the many opinions of recent years, expressed verbally or written, we should say that finality in boilers was yet a long way off. One man believes in water-tube boilers, another in verticals, a third in marine type boilers, while a large majority of steam users will have nothing but the Lancashire type of boiler, either with its circular furnace tubes throughout or with the Galloway modification so well known, and made by Galloways, Limited. In the Galloway boiler, as now made, the inner tube beyond the furnaces is formed of a top and bottom arch struck from the same centre, and joined into a kidney shape in cross section by semi-circular sides. By this means the Galloway tubes which support the flue can all be of the same dimensions, and all point radially from the centre of curvature. The Galloway pipes can thus all be made by special machinery alike in every respect and at far less cost than when the flue was oval-shaped, as it was prior to 1875, when the newer shape came in. As the lower ends of the tubes are smaller than their upper ends, the convergence of the tubes upon the lower arch of the flue brings the pipes closer together, and makes the unsupported surface between the pipes less than it would be without this radial disposition, otherwise the unsupported area of plate in the bottom of the flue tube would be perhaps undesirably great. Full particulars of the boiler are given in the book, and figures of grate area, heating surface and evaporative efficiency, matters of importance in selecting a boiler which are here presented in convenient form. In its flue tube alone the Galloway boiler differs from the Lancashire boiler. The end plates, staying, furnaces and mounting, are identical, and the method of seating is nearly alike. In the manufacture, too, the processes of plate bending, flue tube flanging and welding, shell riveting, drilling, plate planing and other points, are alike. No good boiler maker now omits to plane all plate edges. The thinning of the plate corners when needed is also done by a special planer instead of, as formerly, by fire and hammer, a most important matter where plates are of steel, and local heating would be a source of probable unsoundness and danger. In fact, all the modern points of boiler making are carried out in making the Galloway boiler.

Like the Lancashire boiler, the water surface is large, and this is probably the secret of the dry steam given by boilers of these types. If a boiler primes, it is easy to show an apparently large evaporative efficiency. The test of a boiler is rather what horse-power of an engine it will drive with a given weight of feed water. Unfortunately there is no standard engine, and it is really difficult to get absolute figures. At the Philadelphia Centennial, the Galloway boiler there tested was reported at over 12 lbs. evaporation per pound of fuel from and at 212°. Like the Lancashire boiler, the Galloway has a large water content, and is a steady steamer. Galloways, Limited, are likewise makers of the Lancashire boiler, and they make, also, a water-tube boiler for high pressures, while in engine work they are well known for their superposed engines and engines for rolling mills and ironworks purposes generally.

The opinion of a boiler maker is always apt to be colourably influenced in favour of his own particular make of boiler, but as we report elsewhere, Mr. Norbury, of Messrs. Galloway's firm, states that though they make the best of water tube boilers they do not find that it can touch either the Galloway or the Lancashire boiler in efficiency.

As regards durability Mr. Norbury informs us that Galloway boilers at work over 30 years have been removed in good condition, having simply been made to retire in favour of a higher pressure. A great advantage possessed by Messrs. Galloway as large boiler makers is that they keep a stock of standard size boilers some 40 or 50 in number, ready to deliver to urgent customers. When a boiler usually requires about six weeks to make in the ordinary shop routine, it is a decided advantage to be able to hand them out like tin tacks. This they can do from their new works, which are now situated at Openshaw, near Manchester, and not as formerly at Knott Mill. This works is now all given over to the engine department.

THE WORKING OF LONG SUBMARINE CABLES.*

By R. M. SAYERS and S. S. GRANT, Students I.E.E.

(*Concluded from page* 67.)

Speed of Signalling.

In practice, speed is not reckoned by so many a per signal, but by what is called the "speed constant," thus:—

$$\text{Letters per minute} \times K R = \text{speed constant} = C,$$

or

$$v = \frac{C}{K R},$$

where v is the speed in letters per minute. This constant is about 500 with uncurbed signals with condensers at either end, and about 720 when curbing is used, though a constant as high as 900 has been obtained experimentally with automatic curb transmitters.

In the 1894 Atlantic a speed constant of 500 corresponds to 203 letters per minute, or about 30 words; this is about $1{\cdot}14a$ per signal, with a constant of 720 we should get $0{\cdot}791a$ per signal. This is on a basis of 3·7 signals (dots or dashes and spacing) per letter.

K R depends on the relative proportions of copper and gutta-percha in the core of the cable; from this Willoughby Smith gave the following formula for the speed of transmission in signals per minute:—

$$v = \frac{1{,}297 \times d^2 \times \log \frac{D}{d} \times 10^5}{L^2}$$

where d = diameter of copper, D = diameter of gutta-percha, L = length in nautical miles.

The constant 1,297 will be different for other kinds of gutta-percha than Willoughby Smith's.

This formula gives 232 signals, or 58 letters per minute on the French Atlantic, or $1{\cdot}05a$ per signal (K R = 8·4). Quicker speeds are obtained by modern methods.

Receiving Instruments.

Mirror Galvanometer.—This galvanometer devised by Lord Kelvin, consists of a small magnet, made of a piece of steel spring, supporting a concave mirror which is suspended, top and bottom, by a short silk fibre inside a copper tube, T, fig. 13. Round this tube, T, the coil is wound, the controlling magnet, M, being placed as shown. The instrument is made very dead-beat, partly by means of the copper tube which damps the motion of the needle, and also, if necessary, by the tube (which is fitted with glass ends), being filled with glycerine and water.

A beam of light from a paraffin lamp is directed on the mirror which reflects it back on to a screen; by the motion of this spot of light we are enabled to read the signals.

It is interesting to note that mirrors were first applied to galvanometers for this purpose.

The next instrument is the siphon recorder, also invented by Lord Kelvin; there are two or three forms made by different makers, as an example we will describe:—

The Siphon Recorder (Muirhead's Patent).

The siphon recorder is constructed on the principle of the D'Arsonval galvanometer: it consists of a moving coil suspended between the poles of a strong permanent magnet by means of silk

* Read before a students' meeting of the Institution of Electrical Engineers.

fibres. This coil controls the movements of a delicate glass siphon, one end of which dips in a vessel of ink and the other records the motions of the siphon on a moving band of paper. The friction between the end of the siphon and the paper would, however, greatly impede the motion, and to obviate this the siphon is kept in vibration by means of an electro-magnet. It thus only touches the paper at intervals, tracing a series of dots. Fig. 14 shows the general

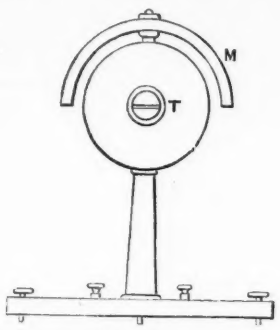


Fig. 13.

arrangement of this instrument. A drawing of the coil and siphon and their suspension is shown separately (fig. 15). This portion of the instrument works up and down on a rack and pinion so that the position of the coil between the poles can be adjusted.

The coil is suspended by two silk fibres at the top and one at the bottom. For very long cables, where the speed of transmission is slow, only one fibre at the top is used. In the centre of the coil is a fixed soft-iron core. The siphon is attached to an aluminium

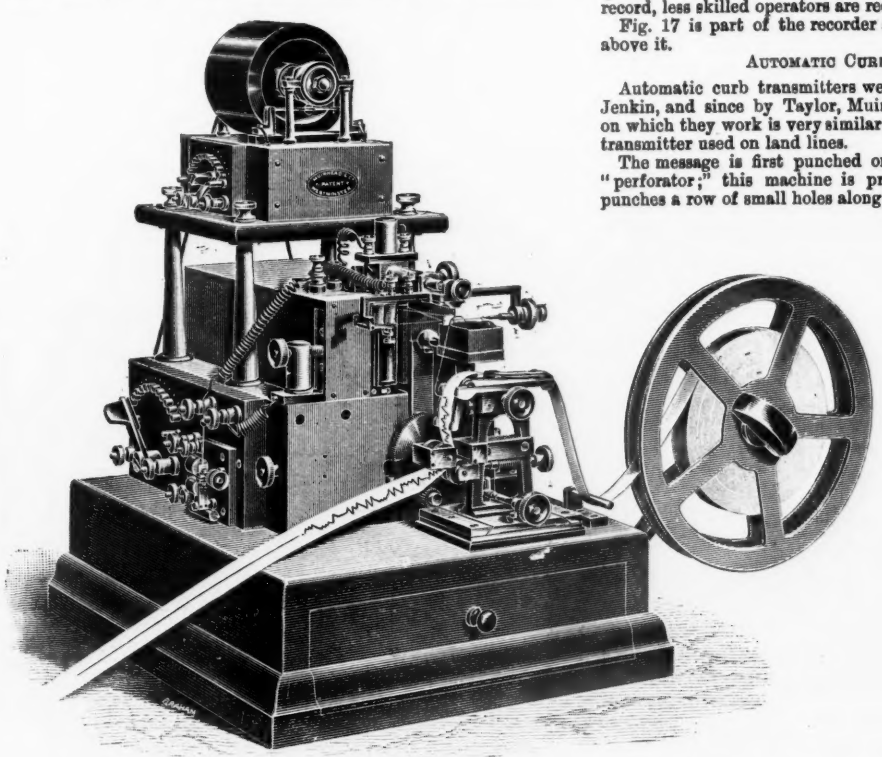


Fig. 14.

carrier or "cradle," supported by a phosphor-bronze wire, which is stretched across the bridge piece. One end of this wire is fixed to a milled head for adjustment of the tightness, and the other to the armature of an electro-magnet, the "vibrator."

The intermittent current is supplied to the vibrator by an interruptor, similar to an ordinary electric bell. The rate of vibration can be regulated by the position of a weight on the armature of the interruptor. Fig. 16 will more fully explain how the motion of the coil is communicated to the siphon. Formulæ for the best resistance of the coil have been given, but in practice it is usually about 500 ohms for long lines.

The permanent magnet is built up of a number of plates. The distance of the poles from the coil can be regulated by a screw adjustment.

The paper strip is driven by a small electromotor worked by four tray cells. A motor is found more suitable than clockwork, not requiring winding up, and in hot countries clockwork is liable to clog.

The coil is provided with two sets of slide shunts for sending and receiving. The first can be varied from ½-ohm to 3 ohms, the second from 250 ohms to 6,000 ohms. The first is only used when a record of the sent message is required.

The tightness of the suspension should be so adjusted that the periodic time of the coil corresponds with the speed of transmission.

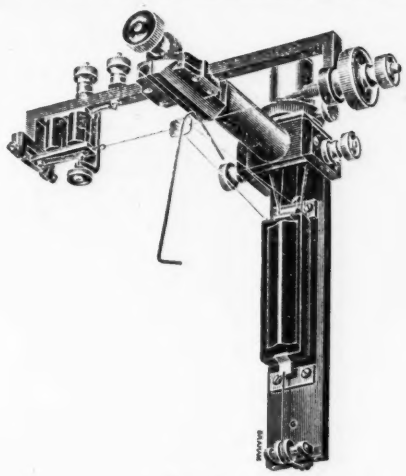


Fig. 15.

The great advantage of siphon recorders is not that they are any quicker than mirror galvanometers, but that as they give a permanent record, less skilled operators are required.

Fig. 17 is part of the recorder alphabet, the Morse code is shown above it.

Automatic Curb Transmitters.

Automatic curb transmitters were first devised by Thomson and Jenkin, and since by Taylor, Muirhead, and others. The principle on which they work is very similar to that of Wheatstone's automatic transmitter used on land lines.

The message is first punched on a paper ribbon by means of a "perforator;" this machine is provided with three punches, one punches a row of small holes along the centre of the ribbon, and the

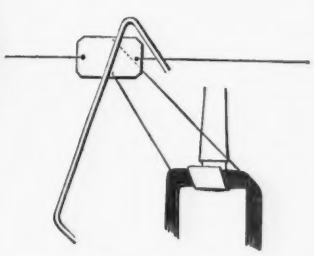


Fig. 16.

two others punch slightly larger holes on either side. The centre line of holes engages with a toothed wheel which draws the paper through the perforator and also through the transmitter. The other

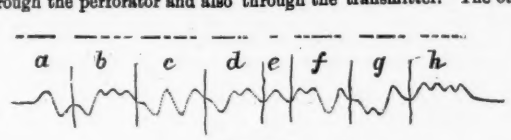


Fig. 17.

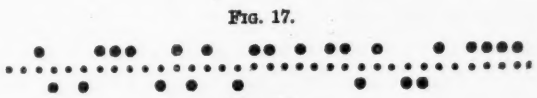


Fig. 18.

holes are perpendicularly above the holes in the centre; a hole on the upper side of the ribbon gives a dot, one on the lower a dash. (See fig. 18.)

In the transmitter itself there are two needles, one directly under each of the two outer rows of holes: if a hole in the upper row pass over these needles, one of them will rise through the hole and a negative current will be sent through the cable, giving a dot; if one of the needles had passed through a hole in the lower row a dash would have been sent.

This is the principle of most transmitters, as an example we will describe:—

Muirhead's Patent Automatic Curb Transmitter.

Fig. 19 is a diagram explanatory of the action of this instrument. There are two levers L, L, connected respectively to line and earth as in an ordinary hand key. The two pairs of contacts x, x and y, y, correspond with the cross pieces of a hand key; x and x are joined together and connected to the centre of two batteries, B_1 and B_2. y and y are also joined, but whether they are in connection with the other terminal of B_1 or B_2, depends on the position of the lever, L_3, which acts as a two-way switch. In their normal positions, L and L rest on y and y, and the cable is to earth.

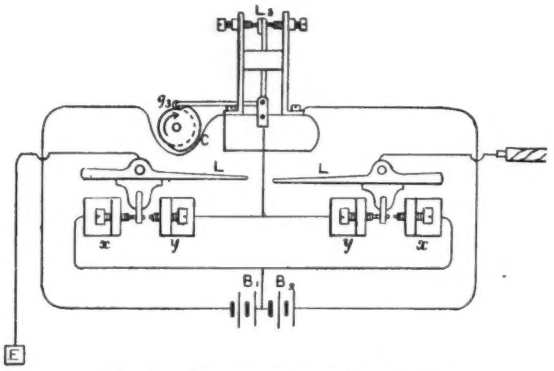


FIG. 19.—DIAGRAM OF CURB TRANSMITTER.

Let us suppose that one of the needles mentioned before has just passed through a hole in the upper row, the left hand lever will make contact at x, and the pawl g_3, will have just fallen over the edge of the cam C and L_3 will press against the left hand contact. In this position the battery B_1 sends a current to earth and back by the cable, this is a negative current or dot, but while the left hand lever makes contact at x, the cam C revolves once, and during the latter part of its revolution L will press against the right hand contact: in this position B_2 will send a current through the cable and back by

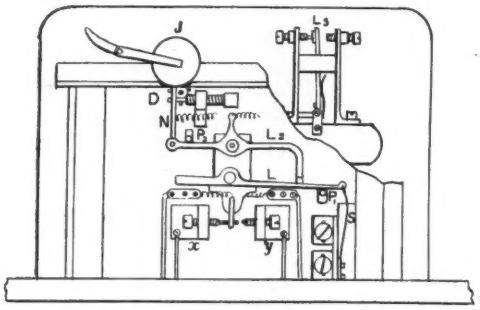


FIG. 20.—AUTOMATIC CURB TRANSMITTER.

the earth; this current will curb the first. The left-hand lever will then return to its normal position at y, and the instrument is ready to send another signal.

If the right-hand lever had fallen instead of the left, owing to a needle having passed through a hole in the lower half of the ribbon, a positive current would have been sent to line (giving a dash) followed by a negative curbing current. If both fall the line is put to earth.

Referring to the next diagram, fig. 20, we will try to explain how the above cycle of operations is effected.

The punched paper strip is drawn under the jockey roller J by the toothed wheel, D, engaging in the centre row of perforations. J also has teeth cut in the centre of its periphery into which the teeth of D fall. N is one of the needles which pass through the outer rows of holes; this is fixed to the lever L_2 which moves the lever L, which actually makes the contacts; there is another needle N with lever L_2 attached, and another lever L_1. These are not shown in the drawing, being directly in front of the other set. When a hole in the strip passes over the needles N, pin P_2 rises, this permits L_2 to be pressed down by the spring attached to it, and push the needle N through the hole in the paper; at the same time that P_2 rises, P_1 falls and permits lever L_2 to press down the lever L and make contact at x where it is kept by spring S; P_2 then falls, pressing back L_2 and withdrawing the needle N, thus permitting the paper strip to move on, afterwards P_1 will rise bringing back the lever L to its normal position, when a fresh hole will have come over the needles N and another signal can be sent, the same operations being performed. It must, of course, be recollected that during the time L is depressed, the cam actuating L_3 revolves once and the curb to the signal is sent.

The motions of pins P_1 and P_2 are effected by cams C_1 and C_2 which revolve on same axis as cam C which works the curbing lever, L_3.

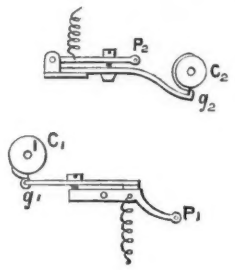


FIG. 21.—CAMS.

The pawls g_1 and g_2 fall over the steps of their respective cams a the same instant, thus P_2 rises and P_1 falls, the cams revolve, g_2 rises on its cam and P_2 is pressed back to its normal place and withdraws the needles; just as C_1 has completed its revolution, g_1 rises on its cam and P_1 is pressed up into its first position, thus bringing back the lever; L a new signal would then be sent. The shapes of the cams C_1 and C_2, should particularly be observed, as it is by this means that the needles N rise and fall again immediately, allowing the

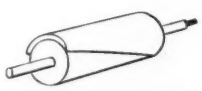


FIG. 22.—CYLINDRICAL CAM.

paper to move on (the paper is always moving) and also one of the levers L is kept depressed for a definite space of time while a signal is being sent (see fig. 21).

The relative duration of curbing to signalling current is determined by the position of pawl g_3, actuating L_3, on cam C, and this can be adjusted by a milled head and screw which moves the ebonite platform carrying L_3 parallel to axis of C (see fig. 22).

Thomson and Jenkins's Automatic Curb Transmitter.

Fig. 23 shows this instrument. A and B are the signalling levers, and A′ and B′ are the curbing levers.

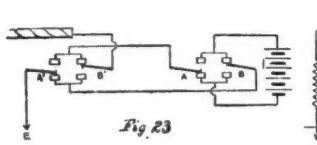


Fig 23

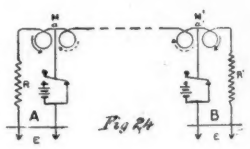


Fig 24

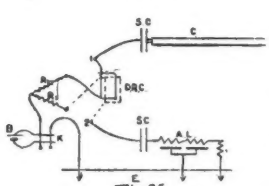


Fig 25

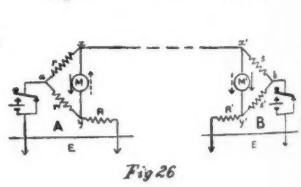


Fig 26

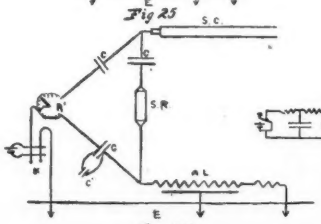


Fig 27

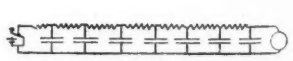


Fig 28

When A is up and B is down, a positive current followed by a negative curb is sent to line; in the position shown, when B is up and A is down a negative current is sent. The positions of these two is controlled by an arrangement of cams and needles.

While A and B are in this position, A′ and B′ are as shown, but during the latter part of the signal, B′ falls and A′ rises, thus producing the curb.

The cams working A′ and B′ are on the same axis as those working A and B: by moving them relatively to the latter pair we may obtain a double curb of three currents, as described before.

This instrument never had any very extended use; nor did the hand curb-key of Varley, but during the last year or two the use of automatic transmitters has largely increased. By their use we may increase the speed of transmission by at least 40 per cent. In fact by the use of this instrument a speed constant of 900 has been obtained.

Duplex Telegraphy.

By various arrangements two messages can be sent simultaneously in opposite directions through one line. In cable work only two methods are employed, the differential and the bridge systems.

The Differential System.

Fig. 24 depicts an ordinary short land line duplexed on this principle. The coils of the receiving instruments M and M′ are each composed of two coils starting from the point a in opposite directions or what comes to the same thing, one coil divided into two parts at a; a is connected to the key as shown, one end of the coil is joined to line and the other to earth through a resistance, R, equal to that of the line as measured from station A. Similar connections at B.

On A depressing his key, the current from the battery has two paths open to it, one through the line and one half the coil of B's instrument and to earth where the signal is received, and the other through the resistance R to earth; now both of these currents pass round A's own instrument, H, but in opposite directions, and the currents are equal because R = resistance of line and instruments at the other end, hence they will have no effect on A's own instrument.

Now suppose B depresses his key at the same time as A, he will tend to send a current in the opposite direction to A, hence the apparent resistance of the line will be increased and more current will flow through the instruments at each end in direction of the firm arrows than in the opposite sense; hence it will be seen that each instrument will behave as if affected only by the current sent from the further end. If the line had no leakage the two currents would exactly neutralise one another, and there would be no current in the line at any point, the two batteries being supposed of equal strength. But there always is some leakage; in this case the *total* current taken all along the line would be zero, although there will be a certain current due to leakage at each point of the line.

In submarine work signals are sent by currents of opposite sense, so let us consider what happens when A sends a $+$ ve current to earth while B sends a $-$ ve one. These two currents would both pass through the line in the same direction and the E.M.F.'s will help one another, hence the apparent resistance of the line will be decreased, and more current will pass through the instruments in the direction of the dotted arrows than in the opposite way. A's instrument will behave as if B had sent a $-$ ve current, *i.e.*, from B to earth through A's instrument and line back to B, and B's will behave as if A had sent a $+$ ve current, *i.e.*, through the line, through B's instrument to earth and back to A. If there had been no leakage the current through the instruments in the direction of the dotted arrows would have been double that in the opposite direction, for we have double the battery power in circuit: as there is leakage is will not be quite double.

In cable work, in place of R, we put an artificial line having exactly the same resistance and capacity as the cable itself. By this means the current, on depressing the key at A, will always be equal in each half of the coil of A's instrument, and on putting the key to earth the discharge currents from the cable and the artificial line will neutralise one another as to their effect on the instrument at A; in fact, it will easily be seen that exactly the same conditions prevail as before.

Fig. 25 is the actual arrangement used in cables (Stearn's method).

D R C, is a differentially wound siphon recorder.
R_1 and R_2 are adjustable resistances.
C = cable.
S C = sending condensers.
A L = artificial line.
K = sending key or transmitter.
B = battery.

The recorder can be shunted if necessary across terminals 1 and 2.

The Bridge Principle.

The differential system is dependent on producing an equality of *currents*, the bridge method on an equality of *potentials*.

In the bridge system the connections are as fig. 26; it will be seen that each end is connected up as a Wheatstone's bridge with the line and instruments at the further end as the fourth arm, we will assume R and R′ equal to l the resistance of the line and instruments at the further end (which is always the case in submarine work), then $r = r'$ and $s = s'$. On depressing the key at A, the current will divide at point A, part going to earth through r' and R, and part going through r, the line and the instrument and bridge at the further end to earth.

The P.D. between x and y will be zero, hence A.'s instruments will not be effected, but B.'s will be in the ordinary way. If, however, B depresses his key at the same time, the apparent resistance of the fourth arm will increase owing to each E.M.F. opposing the other, thus potential at x will be higher than at y, and potential at x' higher than at y', and a current will flow in direction of firm arrows, *i.e.*, each instrument behaves as if effected by the current from the further end alone.

Second Case.—Let A send a $+$ ve current while B sends a $-$ ve. These two currents tend to flow through the line in the same direction, and the E.M.Fs. of the batteries help one another, hence the apparent resistance of the fourth arm will be decreased and currents will flow through the instruments in the directions of the dotted arrows, for x will be at a lower potential than y and y' at the lower potential than x' (it will be recollected that B is sending a negative current). This is exactly what would have happened if we had had two separate circuits. In cable work R, R′ are replaced by artificial lines equal to the cable.

The adjustable arms of the bridge can be replaced by condensers as in the Wheatstone bridge. This is the arrangement used by Messrs. Muirhead & Co. on the Eastern Company's lines (see fig. 27); S R, siphon recorder; A L, artificial line; C, condensers; K, key; S, C, submarine cable; R′, rheostat of $\frac{1}{4}$ ohm coils for adjustment; C^1, adjustable condenser. This is very largely used.

Artificial Lines.

As stated before, a submarine cable is made up of distributed capacity and resistance; this we can easily imitate by suitable employment of condensers and resistance coils.

Fig. 28 depicts such a line consisting of a series of condensers; one plate of each is connected to a common wire forming the "earth": the other plates are connected together by resistance coils. This is the conductor of the cable which is thus made up of distributed capacity and resistance. In order to construct a perfect artificial line, this subdivision would have to be carried to an infinite extent. This has been effected in a most ingenious manner by Messrs. Muirhead and Taylor (see fig. 29).

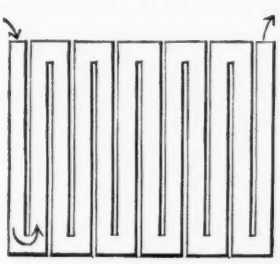


Fig. 29.

One plate of each condenser is made of a long strip of tinfoil, arranged as shown. This supplies the resistance, and taken with the other plate, which is of the usual form, gives us the capacity. Fig. 30 fully explains its action.

Strips of paper impregnated with plumbago have been used in place of the tinfoil because of the high specific resistance of plumbago, but there is difficulty in making good connections.

The artificial line should be as nearly as possible an exact reproduction of the real cable. If there happens to be a slight fault at any point in the real cable, the point corresponding in the artificial cable should be joined to earth through a high resistance.

Recent Proposals.

The fact that a fault or leak in a long cable, by facilitating discharge, improves the definition between signals, and hence enables an increased speed of working is generally accepted by electricians.

Fig. 30.

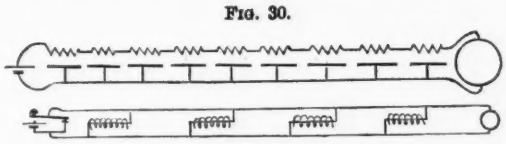


Fig. 31.

The mathematical calculations of Oliver Heaviside prove that by "proper leaks" along the cable, or by greatly diminishing the insulation resistance, a speed of transmission may be reached which is double the present speed.

To attain this object the insulation resistance should be reduced to about 1 megohm per nautical mile. Mr. Heaviside has stated that there would be still enough current arriving at the distant end to work with, but, in spite of his high authority, it is a point which is very much disputed.

Working upon this basis, Prof. Silvanus Thompson has devised a new form of cable, which may be described briefly as follows (see fig. 31):—

The cable has two copper cores, each insulated by gutta-percha. There is no earth return. One core acts as the return to the other. At the receiving and sending stations are instruments connected up between the two cores.

As positions $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, of the length from the end, a wire of greater resistance than the conductor is joined to the first core and runs in the insulation for some 100 miles before being connected to the second core. This is known as a *stretch*. This fine wire is bound round with iron wire, which owing to self induction increases the resistance of this leak. This leak is, therefore, of high resistance to the sudden impulse of the main current, but is not so to the gradually diminishing clinging current which passes along it and into the 2nd core where it mingles with the returning current.

Prof. Thompson states that the cost of manufacture of this new form of cable is only 30 per cent. more than that of the ordinary cable, whereas the speed of transmission is four or five times as great. With five stretches it would be seven or eight times as great.

So much for the theory, now for the practical tests.

Mr. F. A. Taylor says after having made some experiments with leaks distributed at different points on an artificial cable, "that the results did not warrant the assumption that any great increase of speed could be looked for, without employment of a very much larger battery power than usual; the effects of leaks being so to reduce the potential that the received signals were relatively small."

This statement embodies the results obtained by several other experimenters and these results must therefore at present be considered disappointing. Another objection to this form of cable is the extreme difficulty, if not impossibility, of localisation of a fault. But this must not be taken as condemning the principle, and we may have arrived at the germ of a very important development of submarine telegraphy.

In conclusion we wish to acknowledge our indebtedness to Dr. Muirhead for the loan of the instruments exhibited, and to Mr. Edgar for a great deal of valuable information and also to Prof. Ayrton for permission to exhibit the recorder slips illustrating the use of condensers and curbing.

Figs. 19, 20, 21 and 22 are adapted from diagrams in the Eastern Telegraph Company's pamphlet on the automatic curb transmitter.

CASSEL GOLD COMPANY.

By E. ANDREOLI.

Bis repetita placent. Such appears to be the maxim of H. R. Cassel, of New York, who, 14 years ago, sold his so-called process for extracting gold from its ores by electrolysis to the English public. He has just registered in this country a company for extracting gold, the capital of which is a mere bagatelle—£500,000; but such history does not repeat itself, and no doubt the reply to his demand will be "*non bis in idem.*"

There was nothing in the Cassel electro-chlorination which, from the electrolytical point of view, could be considered as true, practical and sound; it could not work—it never did. His present process is no better than the first one.

It is generally known that an aqueous bromine solution dissolves finely divided gold; but Cassel says that he has found that an oxybromide solution, such as is obtained by the electrolysis of bromide of potassium, is a more powerful and more efficient solvent for gold.

This is a rather questionable statement. His tank is divided into two compartments by a diaphragm made of asbestos cloth, which, of course, is not bromine proof; his anodes are made of carbon. Bromine gradually accumulates in the positive department, with formation of bromate of potassium, which is precipitated at the bottom of the tank, and also of bromine gas. At the same time, however, adds Cassel, water is being decomposed, the oxygen of which is set free at the anodes, and then combines with the bromine to form an oxygnated or an oxybromide solution. When the solution in the positive compartment is sufficiently charged with bromine, which can be readily ascertained by its red colour, it is withdrawn through the taps, and flows into a rotating cylinder full of ore, which is revolved during about two hours, until the gold is all dissolved. Then the mixture of ore and solution is dumped into a filter. This is not all. The potash formed in the negative department is used by Cassel to leach the gold and bromine which are still in the tailings. The potash combines with the bromide, and also with the bromide of gold, according to the following equation:—

$$Au\,Br_3 + Br_2 + 7\,K\,O\,H = Au\,(O\,H)_3$$
$$K_2\,O + 4\,K\,Br + K\,Br\,O + 2\,H_2\,O.$$

The gold is precipitated on scraps of iron and pieces of carbon, and the bromine solution from which the gold has been precipitated is again subjected to electrolysis.

Such is the new Cassel electrolytic extraction of gold from its ores.

Mr. Cassel ought to read Luckow's paper, in which, among other things, he will find the following: "By electrolysis, iodine and bromine are separated from solutions of iodides and bromides. Sodates and bromates are produced simultaneously from the iodides and bromides of the metals of the two first groups, especially in concentrated solutions. When the solutions of the chlorides, bromides and iodides contain free alkali, only chlorates, bromates and iodates are produced."

This process is not, like the cyanide of potassium process, applicable to quantities of ore representing 100 or 200 tons which are leached in a single tank; besides, it requires agitation of the ore in contact with the solution, which is prohibitive.

It is hardly worth our while to go thoroughly, not into the merits but into the shortcomings and errors of that audacious adaptation of the electric current to the decomposition of bromide of potassium with a view to obtain bromine. Ordinary bromine would be ten times preferable to electrolytic bromine; it is not a better solvent of gold than chlorine, and electro-chemists will be surprised to see that such a clever man as H. R. Cassel has not thought of decomposing chloride of sodium, which is much cheaper than bromide of potassium, and of sending chlorine and water through the auriferous mass of ore. There are very obvious reasons which prevent him from making such a suggestion.

There is not an electro-chemist who does not know that he can produce chlorine by the electrolysis of a chloride of sodium solution and apply it to auriferous ores for dissolving gold. If he chooses to electrolyse bromide of potassium, he is at liberty to do so, and Cassel cannot prevent him from doing it; but surely he will not try it, because he knows that he cannot decompose the whole of the bromide, that only a small percentage of it is really decomposed by the electric current, and that a great loss of an expensive salt would be caused by the agitation of the bromine and bromide solution with the ores.

Is it too indiscreet to ask one question, one only? Why does not Mr. Renner Cassel apply to the Cassel Gold Extracting Company, of Glasgow, for his capital? £500,000 is nothing when a process for extracting gold is good! Mr. MacArthur, of the Cassel Gold Extracting Company, of Glasgow, is very fond of electrolysis; and, in his opinion, electrolysis is better, more efficient, and more economical than zinc for recovering gold from its solutions. Then there is also Mr. Alfred James, of the Cassel Gold Extracting Company, who has applied for some patents for electro-deposition of gold by the electric current. Surely H. R. Cassel would be welcomed by the powerful company, who have not adopted his first process, but have adopted his name!

We have lately been favoured with several wonderful schemes for extracting, by aid of electricity, gold from its ores and its solutions, but there are few which are more remarkable as regards ingenuity, novelty, and originality, than the methods devised by Mr. MacArthur and Mr. Alfred James; and it will be a treat for all persons interested in electrolysis to learn how Messrs. MacArthur and Alfred James have opened a new field, and have struck out something which, although very simple, had never been thought of before.

(*To be continued.*)

REVIEW.

Electro-Métallurgie. By Ad. Minet. 187 Pages. Paris: Gauthier-Villars et Fils, &c.

The book-making machine is used in France as in other countries. When we took up this volume, we had hopes of reading an up-to-date work on electro-metallurgy. We were disappointed, but still have the hopes of one to come.

Take it in the main it resembles the books of household and workshop recipes—the last one copied from the former ones with all the errors, antiquated phraseology, and "popular" chemical terms.

It is one of four volumes, which, according to the preface must be studied in conjunction to obtain an understanding of the subject of electro-metallurgy. Smee, Faraday, Napier, Gore, and others should have been included in the list; but they are not even referred to.

The book is divided into two parts:—One treats of electro-metallurgy by the wet method, and the other by the dry method. The first part is made up of a great number of recipes for electrolytic baths for plating, or for deposition, or for refining the several economic metals such as gold, silver, copper, lead, &c., but the practice is left out.

The second part is somewhat better in respect to practice, but still sadly deficient.

There is enough information to supply the proverbial knowledge so dangerous to the student.

Why water ("Eau" *sic*) should, in the table on page 21, be classed among the *elements*, with hydrogen, gold, copper, zinc, potassium, &c., and have its formula written HO, is past finding out.

We find many such pieces of precise, but incorrect, items as this about tanks, or vats, for depositing purposes in general:—"la hauteur est égale à une fois et demie et la longueur à deux fois la largeur."

There is not the slightest reason set forth for assuming that for the generation of electricity power by the "Forces naturelles" costs sometimes one-tenth and sometimes one-ninth of the cost by steam, as shown by the table on p. 27. This is followed by an equally incorrect statement of the cost of a water-power installation for electric purposes. Engineers well know that circumstances vary so much that cost has to be determined in each individual case.

There is generally a *motif* for each book. Can it be that this paragraph on page 84 contains it?

"*Procédé Minet.* (The Author.) Je pense arriver à rendre practique un procédé qui a quelque analogie avec le procédé Gaze; d'une application plus simple et plus économique peut-être. . . . . Son étude n'est pas assez avancée pour qu'il soit encore possible de la décrire."

All hail! The coming Man! Messieurs, gold miners, stop your mills and electro-deposition of the precious metal from your cyanide solutions, for the *Procédé Minet* is on the way, and when it arrives——but, perhaps, you are not "*plus simple.*"

CORRESPONDENCE.

Regulating Boosters.

I should be much obliged if you would inform me, through your paper, of the best method of connecting up a booster (of the single armature with two commutators type) for charging cells. The regulation cannot be effected through the field coils, as any reduction in the magnetic flux, with a view to decrease the volts of generator, increases the speed of the motor. As there is a Neville cut-out to be placed in circuit with the cells, it would not do to use a series resistance in series with cells, as no regulation could be effected till there was a current through the series resistance.

Could the speed of the motor be satisfactorily regulated through a resistance in series with the motor windings, keeping the excitation constant?

I enclose diagram of connections.

"Reader."

[The method proposed, namely, inserting a variable resistance on the armature of the motor side of the booster or motor generator is the one usually adopted and is effective. —Eds. Elec. Rev.]

The New Earthing Device.

We are somewhat surprised to note that in your last issue our good friends, Messrs. Drake & Gorham, should have seen fit to criticise the Steele & Johnson earthing device in so harsh a manner.

Surely it would have been fairer to wait until they had an opportunity of inspecting and testing this instrument.

We hope, at an early date, to afford Messrs. Drake and Gorham, in common with the remainder of the electrical industry, an opportunity of testing the merits of this device, but in the meantime, we may say that we are satisfied with the novelty and validity of the patent, and before accepting the sole license for the manufacture of these instruments, we naturally sought expert opinion and advice.

We believe, ourselves, that the invention is not only novel, but that the patent is perfectly valid, and does not infringe on anything previously done.

Veritys, Limited.

July 21*st*, 1897.

Commutator Bars.

I would like to ask if anyone finds Messrs. Bolton's "List of stock sections of commutator bars" of any use? It gives only three dimensions, "width and thickness on thick and thin edges," but no statement of angle between the inclined sides nor, what would be better, the number of bars which make a complete circle. Some month's ago I asked Messrs. Bolton to supply a list giving these desirable figures, but they replied that their customer's are quite satisfied with the list as it is. I have applied

$$\frac{t_1 - t_2}{2\,w} = \tan\frac{1}{2}\,\text{A}$$

to some hundreds of their stock sizes, with the exasperating result that the angle is such that the bar, in many cases, will not make up into a complete circle with parallel mica. The list is, therefore, not practical, and leads me to order special sizes in nearly every case after wasting time calculating what should be stated by the maker. The list does not even state the quickest way of arriving at the number of sections. It only "requests that this number shall be stated on all orders."

Theodore Stevens.

LEGAL.

British Aluminium Company *v.* Armstrong, Mitchell & Co.

At the end of last week before Mr. Justice North, learned counsel (Mr. Graham) mentioning this case, said that it was a motion for judgment in default of delivery of defence. The action was to restrain the infringement of patents relating to aluminium. A defence was put in a long time ago, but was subsequently withdrawn; so now it was just the same as if no defence had been filed. The plaintiffs did not ask for an inquiry as to damages, because the damages were very small. All they asked for was an injunction and the delivery up of any aluminium which the defendants had in their possession, and a reference to the taxing master to tax the costs.

His Lordship made the order asked for.

Yell *v.* Rounds Accumulator Company, Limited.

The plaintiff in this action, Mr. C. H. Yell, an electrician, sued the defendant company at the Lord Mayor's Court, to recover the sum of £36 5s. for rent of offices alleged to have been used by the defendant company.

Mr. Wildey Wright, who appeared for the plaintiff, stated that his client was formerly in the employ of the syndicate, which was afterwards formed into the defendant company, and he was directed by the syndicate to find offices for the company. He accordingly did so, and by desire of the signatories, who were then acting as directors of the company, he took offices in his own name, becoming responsible for the rent. A quarter's rent was paid by the signatories, but after that plaintiff was unable to get any rent from the directors of the company. The defendants stated that they had never used the rooms, and that they had transferred to plaintiff certain furniture in payment of rent. The plaintiff alleged that the furniture was only worth £6, and it was unlikely that he would accept it in payment of his rent. On being cross-examined, plaintiff admitted that he was convicted at the Central Criminal Court in January last and sent to gaol for a month for forgery. Eventually the jury returned a verdict for the defendant.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—Under the failure of Sir Wm. E. J. Vavasour, Bart., of Tadcaster, Stoke-on-Trent, and London, the first meeting of creditors was held last Monday, at the London Bankruptcy Court, before Mr. A. H. Wildy, official receiver. The debtor having for 13 years acted as Commissioner in lunacy, succeeded to the estates in 1885. They are charged to the extent of £99,000, and the income is not sufficient to provide for the charges, interest, and maintenance, to which fact the debtor ascribes his appearance in the Bankruptcy Court. He does not regard the estate as being in an insolvent condition, but on the contrary, he is of opinion that if it be properly administered sufficient will be realised to pay in full the total amount of the claims against it and to leave a considerable margin for his benefit. No statement of affairs has yet been filed, but Sir William estimates that in addition to the £99,000 of secured debts, there are unsecured debts to the amount of about £6,000. He further states that having studied electricity for some years, in the course of which he patented certain inventions, he disposed of some of them to the Globe Electric Light Company in 1891 for £5,500 in shares. He was the managing director of that company, also of the Askester Electro-Motor and Accumulator Company, Limited, but neither of them are doing any business and will shortly be wound up. The Chairman reported that the debtor had consented to an adjudication in bankruptcy. The creditors decided to leave the matter in the hands of the official receiver to be wound up in the usual manner. The public examination is appointed for August 10th.

Under the failure of William Marshall, electrical engineer, &c, 16, Tokenhouse Yard, E.C., the first meeting of the creditors was held

on Wednesday at the London Bankruptcy Court, and was adjourned for three weeks with a view to payment of all debts in full. The debtor commenced business in January, 1895, with £1,500 capital, and attributes his failure to losses in connection with the City of Mexico Tramways, and to having accepted shares in lieu of cash from the London Electrical Omnibus Company, which shares he has been unable to realise.

Electrical Wares Exported.

WEEK ENDING JULY 26TH, 1896.	£	s.
Adelaide	26	0
Alexandria	26	0
Amsterdam	178	0
Auckland	13	0
Bilbao	35	0
Bombay	127	0
Buenos Ayres. Teleg. mat.	287	0
Calcutta	50	0
Cape Town	464	0
Colombo	697	0
Copenhagen	68	0
Delagoa Bay. Teleg. mat.	36	0
Durban	667	0
East London	870	0
Flushing	18	0
Gothenburg	325	0
Hong Kong	34	0
Launceston	61	0
Madras	86	0
Melbourne	333	0
„ Teleg. mat.	516	0
Monte Video	50	0
Montreal. Teleg. mat.	30	0
Pesth. Teleg. mat. ...	273	0
Port Elizabeth	206	0
„ Said	64	0
Shanghai	542	0
Singapore	120	0
Stockholm	160	0
Sydney	264	0
Townsville	1,142	0
Valparaiso	40	0
Total	£7,818	0

WEEK ENDING JULY 20TH, 1897.	£	s.
Adelaide	104	0
Aden	10	0
Alexandria. Telep. mat.	29	0
Amsterdam	90	0
„ Teleg. mat.	85	0
Antwerp...	40	0
Bombay	10	0
Bordeaux	40	0
Boulogne	13	0
Cadiz	30	0
Calcutta	66	0
Cape Town	40	0
Colombo	226	0
Durban	235	0
East London	131	0
Gibraltar	1,000	0
Halifax	50	0
Hong Kong	56	0
Launceston	52	0
Madras	55	0
Malta. Teleg. mat. ...	123	0
Otago	6	0
Passages	382	0
Penang	19	0
Port Chalmers	22	0
„ Elizabeth	235	0
Rangoon	70	0
„ Telephone ...	44	0
Shanghai	14	0
Singapore	31	0
„ Telephone ...	28	0
Smyrna. Teleg. mat. ...	36	0
Sydney	1,116	0
Wellington	32	0
Total	£4,520	0

Foreign Goods Transhipped.

	£	s.
Halifax	28	0

Dissolution of Partnership.—Messrs. F. King and W. P. Mendham, hitherto carrying on business at Bristol as electrical engineers, have dissolved partnership by mutual consent as and from December 31st, 1896. Debts attended to by Mr. W. P. Mendham.

Electric Pumping Machinery.—The Worthington Pumping Engine Company, of Queen Victoria Street, have just issued a new edition of their general catalogue, which shows a number of new designs of steam pumping machinery. The various types of Worthington pumps now so extensively used and so well known are illustrated, and a good deal of descriptive letterpress accompanies the illustrations. In electrical pumps we observe the Worthington direct-connected electric pump for house tank and similar service, which is made for 200 or 400 gallons capacity per hour; the Worthington electric power pump, which is intended to meet the demand for a greater capacity than the house tank pump, is made for a capacity of from 450 gallons to 1,700 gallons per hour. The triplex electric mine pump described is designed to deliver 1,000 gallons per minute against a vertical head up to 1,500 feet. The water end consists of six single-acting outside packed plungers, arranged in pairs, driven by three cranks set at 120°. The motive power is furnished by two electric motors coupled directly to a countershaft, and driving the pump through a single reduction of double gearing. The Worthington Triple "Steeple" pump described is directly geared to an electric motor. The catalogue is a small one of very convenient dimensions, and a great deal of information is contained in its 150 pages.

Electrical Engineering in Chili.—The Allgemeine Electricitäts Gesellschaft, of Berlin, is reported to have secured a number of electrical engineering concessions in Chili, included among which is the acquisition of the tramways in the town of Santiago, and the conversion of the same into electric lines. The central electricity supply station is also to be capable of supplying current for lighting purposes. The company has also acquired a concession to utilise the water power of the Naijo River.

Electric Fire Alarms.—The Metropolitan Asylums Board has engaged Mr. H. R. J. Burstall, electrical engineer, to prepare a specification for the execution at a cost of £140 of certain alterations to the electric fire alarm system at the South-Eastern Hospital. Tenders are to be invited.

Electric Signal Lights on Board Ship.—A new patent electric signal light indicator and alarm is being introduced by Messrs. Claud Hamilton, Limited, of Waterloo Street, Glasgow. It is intended for use where electric masthead, side, and anchor lights, or other electric signal lights are fitted, and is for the purpose of giving notice to the officer of the watch should any of these lights fail. The lights are switched on from the indicator erected in the chart room, pilot house, or elsewhere, and should any light go out, an alarm bell will ring and an indicating lamp will light up. The bell will draw the attention of the officer in charge to the fact that some signal light has failed, and its indicating lamp will show which one. A reserve lamp is provided in each signal lantern which, when switched in from the indicator will, if burning properly, automatically stop the alarm bell and extinguish the indicating lamp. Should the dynamo supply fail from any cause the bell will ring, but in this case none of the indicating lamps will light, and the officer will know that the fault lies between the indicator and the engine room. A testing key is provided for each lantern, on pressing which it can be ascertained whether the indicator is in proper working order or not, and also if each signal lamp is burning properly, and this is done without even momentarily breaking the circuit of the signal lamp. The mechanism of the indicator may be used to work other indicating lamps and alarm bells fixed on bridge or other part of the vessel, which work simultaneously with the main indicator. We understand that this apparatus, though only recently brought out, has been already fitted into several important steamers and yachts with satisfactory results.

For English Contractors.—The British Vice-Consul at Bordighera, in a recent report to the Foreign Office, says:—"The English electrical engineers, who obtained a concession for electric lighting, stated that, except to a small extent, it did not suit them to obtain their plant from England, not because of slight extra expense, English electrical machinery being superior to that of Continental manufacture, but because English manufacturers have no branches in Northern Italy, whereas at Turin and Milan branches are to be found of Belgian, German, or Swiss firms, where every information could be found, and prompt delivery of goods guaranteed."

For Sale.—From our "Official Notices," particulars will be obtained of a sale of plant, machinery and stock of the United Gutta Percha and Rubber Company, Limited (in liquidation).

Gas.—A gas explosion at Tyson Road, Forest Hill, on Tuesday, causing damage to life and property.

Incandescent Lamps and Fittings.—Messrs. Downie and Adams, who are carrying on business as electrical suppliers at 24, Newman Street, Oxford Street, W., have sent us a copy of their price list of incandescent electric lamps, which is one of their special lines. There are eight pages of illustrations showing the various styles and shapes of lamps, with crinkled, frosted and cut glass bulbs. Lamp terminals, &c., are also shown. The list is well set out, and good paper and printing are noticeable points.

Liquidation Notices.—A general meeting of the members of the Phonophore Company, Limited, will be held at 85, Queen Victoria Street, E.C., on Wednesday, August 18th, at 4.30 p.m., for the purpose of hearing an account of the winding up proceedings from the liquidator (Mr. Chas. Isaac).

Creditors of the Electrical Installation Company, Limited, are required to send particulars of their debts or claims and the usual information to Mr. J. G. O'Brien, of 135, Victoria Street, S.W., the liquidator of the company, on or before August 31st, 1897.

Speed Counter and Chronograph.—We illustrate below Berend's combined speed counter and split-seconds anti-magnetic chronograph. The instrument can be used for speeds up to 5,000 or 6,000 revolutions per minute. The loose point is inserted in the engine or motor shaft, and by gentle pressure the counting gear

FIG. 1.

and chronograph are immediately and simultaneously started. Fig. 2 shows the face of counter. The long hand of the chronograph counts seconds and fifths, the small dial registering the minutes. Fig. 1 shows a small projecting "ear," or lever, at the right-hand side of the

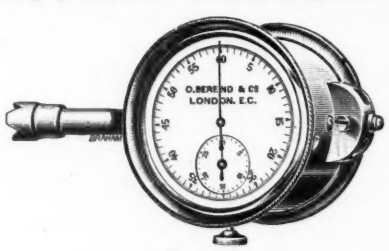


FIG. 2.

dial, and when this lever is pressed, the hands are at once reset. The counters are supplied by Messrs. O. Berend & Co., of Basinghall Avenue, E.C.

Parish of St. Mary, Islington.—An advertisement on page 12 of supplement may interest electric lighting contractors.

Russian Electrical Exhibition, 1899.—At St. Petersburg, early in 1899, an electrical exhibition will be held under the arrangement of the Russian Electro-Technical Society. It is desired to have everything pertaining to electricity on exhibition. The buildings will be somewhere about the centre of the city, and it is intended that electric yachts shall ply on the canals, and that various systems of electric railways, elevators, &c., shall be in operation. It is understood that the Russian Government, the City of St. Petersburg, and the above-mentioned Electro-Technical Society, will furnish the necessary expenses.

The Training of Electrical Engineers.—A pamphlet with this title has been issued, dated June, 1897, by the Electrical Standardising Testing and Training Institution, of Faraday House. The list contains full information regarding the Institution course of training, and also of the various municipal authorities and borough electrical engineers associated with the Institution. Photographs of some of the officials, and views of the departments and works where students spend part of their time, add interest to the pamphlet.

ELECTRIC LIGHTING NOTES.

Ayr.—Various extensions of the mains and the adoption of incandescent electric lighting for lighting certain streets, as recommended by the electrical engineer, Mr. Fuller, have been agreed to by the Council. The old gas lamps will be used for the incandescent electric fittings. Arc lamps are to be put up in several places.

Aberdeen.—The Aberdeen Works have been busy for the last three months making preparations to change over their entire system from one of 110 and 220 volts to one of 220 and 440 volts and have just effected this change over, the supply now being given at 440 volts between the outers. This change has been effected without for one moment discontinuing the supply, and the Corporation have already or are at present thoroughly overhauling the whole of their consumers' wiring, and have changed at their own expense the equivalent of 26,000 lamps of 8 C.P., made up of incandescent lamps, arc lamps, and motors. No consumer is supplied with current at 440 volts. In case of old three-wire installations the difficulty has been got over by bunching the two old outers together and making one pole of them, and using the old middle wire for the other pole. They have been enabled to do this in every case, the middle wire having usually been put in of the same section as each of the outers in the original wiring. All the dynamos in the Works have been or are being rewound for the increased voltage, and although Aberdeen was long behind larger works such as Edinburgh and Bradford in commencing the change over, they claim to be the first works to actually complete the work. The whole of the arrangement and work has been carried out by Mr. Alfred Blackman, the electrical engineer to the Aberdeen Corporation.

Beccles.—The Council has appointed a committee to report on the question of electric lighting the town, the present system of incandescent gas lighting having been found so unsatisfactory, that it has been resolved to discontinue it.

Belfast.—There was no opposition last week to the application by the Belfast Corporation for a loan of £125,000 to build an electric light station, and carry out other improvements in the city. The sum set down for electric lighting is £65,000.

Bermondsey.—The Vestry has resolved to oppose the Brush Provincial Electric Lighting Company and the Bourne and Grant Company in their respective applications for provisional orders.

Bootle.—The electric lighting scheme, to which we referred at length last week, has been adopted by the Town Council. The total cost is £35,000 for 8,000 8-C.P. lamps.

Bradford.—The two resolutions to which we referred last week duly came before the Council. That proposing to raise £50,000 for electric lighting extensions was carried unanimously, but Mr. Jowett's motion regarding the lighting of the Lister Park was only carried so far as concerns the institution of inquiries by the committee. The question of doing the work depends upon the result of the inquiries.

Bridgwater.—The Town Council on 15th inst. decided to adopt the report of the Lighting Committee, which suggested that electric light on the low tension system should be used throughout the borough.

Broadstairs.—The Broadstairs and St. Peter's District Council have resolved to oppose the application to Parliament by the Bourne and Grant Electric Lighting Company, Limited, for powers to supply electric light and energy in the district.

Cardiff.—The Corporation has offered to supply electric current to the Workhouse at the rate of 6d. per unit for the first hour, and 1½d. per unit for subsequent hours of lighting each day. The Clerk has been instructed to ask the Corporation to give an estimate of what the annual cost of lighting would be.

The Council has resolved to increase Mr. Applebee's (the electrical engineer) salary from £200 to £300. Mr. Applebee submitted figures showing salaries paid to borough electrical engineers in other towns.

Cardiff.—The City Council last week discussed two applications for permission to run overhead insulated electric light wires across Bute Street. The Public Works Committee had given the permission conditionally, but the Council by a large majority refused to do so. One speaker said that the Public Works Committee insisted upon one of the firms applying to the Board of Trade for consent. The Board of Trade offered no objection, and he did not see why the Council should object.

Chislehurst.—At a meeting of the Council on Friday, the clerk reported the reception of the draft license of the Chislehurst Electric Lighting Company by the Board of Trade, to whom the company have to give security of £1,000, to show that they are able to carry the work out. This form of procedure was adopted in order that the company might start work at once, without waiting for the passing of the provisional order, which is to be applied for in the next Session of Parliament. The price charged to private consumers is fixed at 13s. 4d. for 20 units, and after that at 8d. per unit, and for public lighting the price has to be fixed by mutual agreement or arbitration. The Council approved of the draft license.

Coventry.—The Electric Light Committee recommend an extension of both the generating plant and the supply mains. They also recommend the adoption of arc lighting in certain streets, 40 lamps being used. It is proposed to put down one 300 kw. steam alternator with the necessary addition to the engine room, switchboard, &c. The total length of the streets in which it is proposed to lay mains is 7½ miles. The total cost of the scheme is £37,900, for which application would be made to the Local Government Board.

When the scheme was discussed by the Council on Tuesday, objection was taken to the list of streets along which it was proposed to lay mains, and ultimately it was decided to adjourn the further consideration of the report for a month.

Crieff.—The Town Council, notwithstanding the offer of Sir P. K. Murray of free water power, is far from unanimous respecting the electric lighting question. At the last meeting a resolution was before that body arranging for a report on the subject from a practical electrician. Seven voted in favour of the motion, and five in favour of a motion to reject Sir P. K. Murray's offer. By a majority of two votes, therefore, Mr. Wm. Arnot, of Glasgow, is to be asked to report.

Dundalk.—The Town Commissioners last week approved a copy of the order in Council, dealing with the scheme for construction of a line of electric trams through Dundalk and on to Blackrock, and also the position with regard to the electric lighting scheme. The only amendment made was in the height of the poles carrying the electric wires. These are to be at least 25 feet.

Eccles.—Last week a Local Government inquiry was held respecting the Council's application for power to borrow £11,408 for electric lighting. Mr. S. V. Clirehugh gave evidence as to the scheme. There was some opposition by the Property Owners' Association.

Galashiels.—An electric light company has given notice that it is its intention to apply for a provisional order. The Corporation has refused its consent.

Glasgow.—The report of the Electricity Committee for the year ended 31st May last states that the gross revenue amounts to £30,474 16s. 1d., and the gross expenditure to £12,475 14s. 3d., to which is added depreciation written off capital £10,705 10s.—the balance carried to profit and loss account being £7,293 11s. 10d. The committee had to meet the following requirements:—Interest on loans £4,300 9s., and sinking fund £1,466, leaving a balance on the year's operations of £1,527 2s. 10d. This balance is, in terms of Section 52 of the Glasgow Corporation Electric Lighting Order, 1890, transferred to the credit of the gas account, to meet the deficit in connection with the electricity department for the year 1895, which was borne by the gas department.

The minutes of the Watching and Lighting Committee of July 9th, which were approved by the Council last week, stated that the inspector of lighting had commenced to fit the new arms on the electric light pillars, and that at July 8th 24 were finished and lighted; that as on July 16th four more would be lighted, that would leave 70 to fit on; and that, as it is not possible to finish the work at the present rate by the end of this month, when the Brush arc lamps are to be handed over to the purchaser thereof, it would be necessary to fall back on the gas lamps for a short time. The Committee, having considered the matter, approved of the use of the gas lamps in the meantime.

Gravesend.—The Committee of the Gravesend Town Council appointed to report on the proposals of Crompton & Co., Limited (acting with the Electric Supply Corporation, Limited), also with the Edmundson's Electric Corporation, Limited, and also the Great Western Electric Light and Power Company, Limited, to obtain statutory powers for lighting the borough with electricity, have decided that the matter is too considerable for a committee to deal with, and consequently ask the whole Council to discuss the question.

Hastings.—Last Friday the question of the purchase of the Electric Light Company's undertaking (including the front line plant, for which £3,200 is to be paid), came finally before the Town Council, and the matter was settled. The undertaking will accordingly be taken over at an early date.

Hereford.—A proposal was before the County Council last week in regard to the lighting of the Asylum. A committee proposed to adopt electric light in preference to extending the ga

works. They stated that the initial outlay of an electric light installation would be greater than enlarging the gas works, but the annual saving in the cost of producing electric light will, in a few years, recoup the extra outlay. This economy will be partly effected by utilising the steam at present only used for heating the asylum, to create, in the first instance, electrical power, and afterwards exhaust steam for heating. This method of heating and lighting is stated to have proved thoroughly efficient and economical at Dorset County Asylum. Decision on the report was deferred.

Kintbury.—The lighting of the mansion at Elcot Park with the electric light has been carried out by Edmundson & Co., Limited.

Leamington.—The Town Council has decided, by unanimous vote, to apply for a provisional order for the electric lighting of the town. This decision is an answer to a notice from the local Electric Lighting Company of its intention to apply for statutory powers.

Leith.—The Electric Lighting Committee, which has been going into the questions of electric lighting and tramway haulage, consulted Prof. Kennedy, and he proposed that plant be put down for supplying 12,000 8-C.P. incandescent, and 64 arc lamps. The committee recommended the adoption of the scheme, and that a resident electrical engineer be appointed for the work at £300 per annum. The Council has approved the report, and has voted in favour of providing in the buildings to be erected for tramway haulage. A proposal to see at what price they could obtain current for lighting from Edinburgh was lost.

Lewes.—An electric light company is in communication with the Town Council, and proposes to apply for electric lighting powers for the district. For some reason or other some of the councillors seemed to treat the matter as a huge joke.

Leyton.—Mains are to be extended in Harold Road, so as to supply current to the Great Eastern Railway Temple Mills Goods Station. The Electric Lighting Committee recommend the Council to undertake the wiring of consumers' premises on terms suggested by the resident electrical engineer.

London, E.C.—Last week the Commissioners of Sewers unanimously adopted a recommendation of the Street Committee, that the City of London Electric Lighting Company should be informed that in the future the Commissioners would insist on the due observance of the terms of the agreement in regard to the amounts to be debited for depreciation in the accounts of receipts and expenditure. Mr. Morton complained strongly of the heavy charges made by the Lighting Company to private consumers, and said that the Commissioners had been badly advised in entering into the agreements in reference to the supply of the electric light in the City, and had been "taken in" all round. Some people might have made £100,000 or £200,000 out of the contract by speculation, but it was a bad bargain for the private consumers. In reply to questions, Mr. Morton and others said that every effort had been made to induce the Electric Light Company to reduce their charges; but to all they had received the same reply—that it could not be done at present. We have no doubt that the City Company has so much business at present that it does not need to reduce the price to secure fresh custom; but perhaps we may suggest to the company that the time has come for something in the nature of a reduction being made, as being due to the public. It seems out of all reason that the City Company, with its splendid district, should charge 8d. per unit.

Patrick.—The Commissioners have received notices from the Kelvinside Electric Company and the Imperial Electric Light and Power Company of their intention to apply for provisional orders for the electric lighting of the burgh, and to ask the Board of Trade to revoke the order granted to the Commissioners, on the ground that the latter had failed to carry same into effect.

Portsmouth.—The Electric Light Committee recommends the acceptance of Mr. Quick's tender for raising the roof of the store at the electric light station. The Council has agreed that the price of the electric current for motors be reduced from 2½d. to 2¼d. per unit.

Prescot.—The District Council's lighting contract with the British Insulated Wire Company expires at the end of the year, and a Committee has been appointed to consider whether electric lighting shall be continued, and generally to go into the question.

Prestwich.—The District Council has referred to a Committee to consider whether a firm of electricians shall be allowed to undertake electric lighting in the district and apply for such powers from the Board of Trade.

Provisional Orders.—The Bills containing provisional orders for electric lighting schemes relating to the following places were, on 19th inst., before the examiners in the House of Commons, and were found to have duly complied with the standing orders:—Levenshulme, Moss Side, Stretford, and Withington, Northwich, and Bangor. The Bills will come in due course before the unopposed committee.

Rowley.—The District Council has received notices from the Midland Electric Corporation for Power Distribution, Limited, and the South Staffordshire Blast Furnace Power Syndicate, of their intended applications for provisional orders to supply electricity within the district of the Council.

Rothesay.—The Council will oppose the application of the Electric Power Company for a provisional order.

Ryde.—We learn that the Council will oppose the application of the Ryde Electric Light Company for a provisional order.

Smethwick.—The District Council will oppose the applications of the Midland Electric Corporation and the South Staffordshire Blast Furnace Power Syndicate for provisional orders.

Tottenham.—The District Council has received notice from the Bourne and Grant Electricity Supply Company of intended application for a provisional order.

Wakefield.—It is expected that the electric light undertaking will be completed some time during August. The Electric Lighting Committee made an inspection of the main thoroughfares some days ago for the purpose of arranging the positions of the arc lamps.

Wallsall.—Mr. Robert H. Bicknell, Local Government Board inspector, held an inquiry at the Guildhall, Walsall, on Thursday of last week, respecting an application by the Coporation for sanction to borrow £1,851 for the purpose of electric lighting. Mr. Wylie, the Corporation electrical engineer, gave details as to what was required, and added that the total number of lamps in existence in the borough was 6,357, not including the applications to be joined up. The proposed extensions would give them 1,000 more lamps, for which the Electric Lighting Committee had 350 applications, owing to the increased demand for the illuminant; the summer maximum was equal to last winter's maximum.

Westgate-on-Sea.—Mr. Hawtayne has had an interview with the Council in respect of the proposal to light the district with electricity. Mr. Hawtayne said the high class property in the place made it a fair field for electric lighting. At Westgate gas was 4s. 9d. per 1,000, and he thought, from a rough calculation he had made, that electricity could be supplied at 6d. per unit, which was equal to gas at 3s. per 1,000. It was resolved to consider the question at a special meeting.

Willesden.—Mr. W. H. Trentham, electrical engineer, has submitted a lengthy report upon the proposed electric lighting of Willesden. He recommends the high pressure alternating system, and discusses the most suitable area and the likely requirements of consumers. The engineer to the Willesden Council (Mr. O. C. Robson) has also drawn up a report discussing the proposal, and he is anything but hopeful as to results.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Brighton-Rottingdean.—The seashore railway is now about to resume running. The car wrecked by the great storm of last December has been replaced. Short trial trips with the new one were made last Saturday. The tests were satisfactory, for the tide was at the full, and the depth of water over the track was 12 to 14 feet. The new car only differs from the old one in the matter of height. The deck now stands at 25 feet instead of 23 feet above the level of the rails. The model of the car is the same.

Calcutta.—The report of the directors of the Calcutta Tramways Company for the year 1896 states that the arrangement with Messrs. Crompton & Co. for the application of electricity to the lines, to which the sanction of the shareholders was given in August last, has not been carried through. The reason for this is that the Corporation declined to grant the necessary consent to the conditions asked by Messrs. Crompton & Co, for the use of electric traction within the time stipulated for in the agreement. After the lapse of the agreement by effluxion of time, the company approached the Corporation on their own behalf on modified conditions, in order to meet the objections of the Corporation. This was in January last, and since then negotiations have been continually in progress, and the directors deferred the holding of the ordinary general meeting, as they felt it would be more satisfactory to be able to place before the shareholders a definite scheme for the altered conditions necessary to re-equip their property. As the continued delays on the part of the corporation to arrive at any conclusion are such as to make it almost impossible to say when any definite scheme can be formulated, the directors feel it is right that shareholders should now be put in possession of all the information which the directors can give, even although it may be necessary to call together the shareholders again when negotiations are brought to a conclusion.

The chairman of the company (Mr. C. E. Morgan) went very fully into this matter in addressing the shareholders at Cannon Street Hotel on Tuesday.

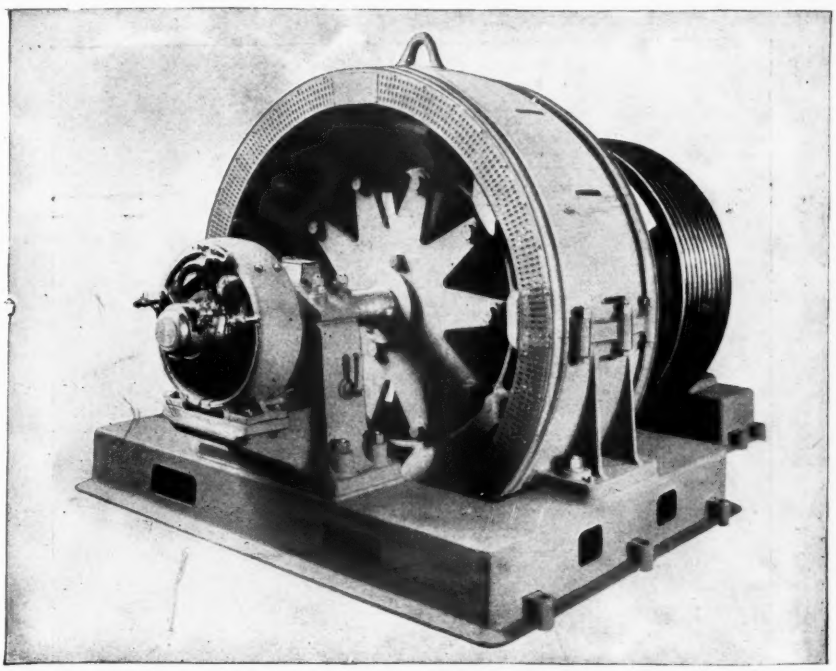
Halifax.—In our "Contracts Closed" we give particulars of some accepted tenders in connection with the electric tramways. Tenders are being invited for the supply of 10 tramcars. The Tramways Committee have decided that at Ward's End the centre-pole system, instead of the side-pole system, is to be adopted.

Liverpool.—The Special Tramways Sub-Committee which was deputed to visit several Continental cities and inspect mechanical and electric methods of tramway haulage, has not yet formally presented its report to the General Committee. It is understood, however, says the *Liverpool Daily Post*, that the report will recommend that an experimental trial be given to the overhead wire electric system.

(*Continued on page* 121.)

THREE-PHASE POWER AND LIGHT PLANT AT LIVERPOOL.

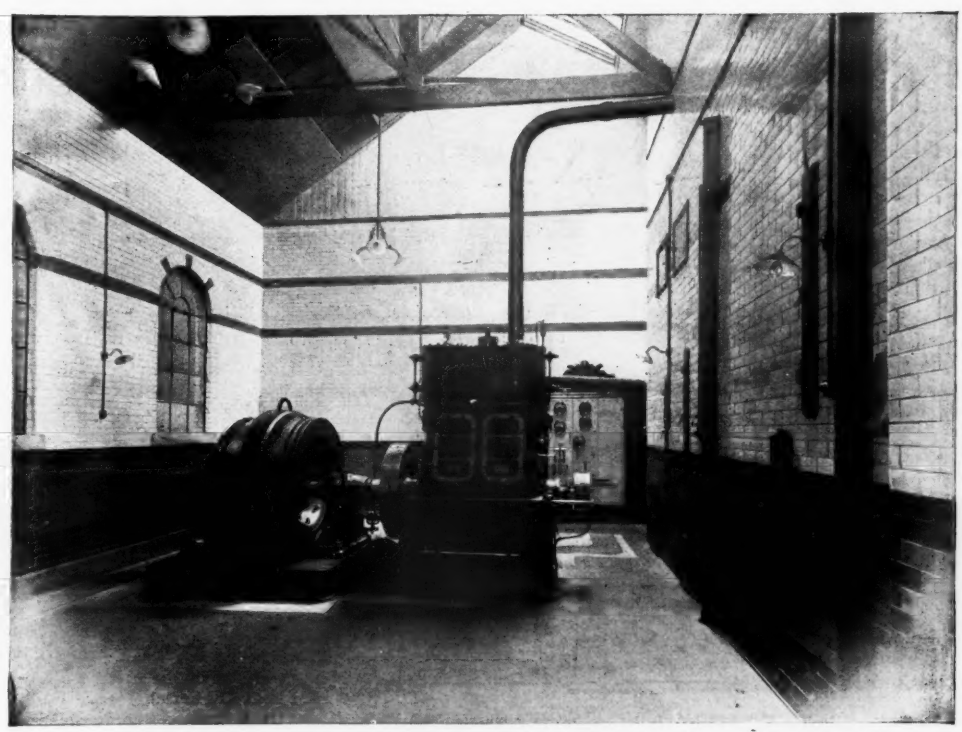
So much has been written and heard of distribution of power by multiphase currents on the Continent and in America, that a description of a plant on the three-phase system, installed by the General Electric Company, Limited, of London and Manchester, for the Liverpool Grain Storage and Transit Company on their premises at Bootle will be of interest as an innovation in this country.



Three-Phase Motor.

The Liverpool Grain Storage Company's buildings are, we believe, the first in England to be completely fitted out with electric lighting and power transmission on the three-phase system. Hence, a short description of the company's premises and plant will be of interest before considering the electrical features of the system adopted.

The Liverpool Grain Storage Company's buildings adjoin the Alexandra Dock No. 3, at Liverpool, and have been recently fitted up with the best types of machinery for handling and storing grain in bulk. The premises extend over an area of about 12,000 square yards, and are divided into



Alternator and Engine.

two blocks. The electrical generating plant is placed in the eastern block, and the western block contains, at present, the great majority of the electric motors and lamps.

The grain is brought alongside the wharf in barges, and

the outside leg of the elevating tower is then lowered into the hoppers. The chain of buckets inside this leg elevate the grain to a certain height, and discharge into the bunker of the inside elevator. This elevator, which also consists of a chain of buckets, lifts the grain to the top of the elevator tower, where it is discharged into a hopper over the weighing machine. The grain is then weighed in lots of 5,000 lbs. each, an automatic record of the weight passed being kept. It passes from the weighing machine on to one of two main conveyors. The elevator tower is placed in the centre of the wharf frontage, and the two main conveyors carry the grain in one or other direction across the end of the sheds which run at right angles to the dock wall.

These conveyors consist of 30-inch belts of canvas and vulcanised rubber, which are continually running. The grain is deposited on the end, and can be taken off at any point at will to be deposited in either of the sheds.

These conveyors are worked independently of each other by separate electric motors, and have an effective length of about 80 yards. The grain is taken from these belts on to smaller portable conveyors, suspended temporarily in the sheds, which place their grain where required on the floors. The total quantity which the elevators and conveyors are capable of handling in one hour is 160 tons.

Fig. 4.

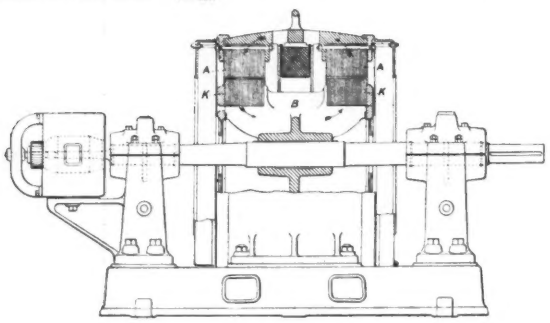


Fig. 1.

A small portable conveyor is also provided and electrically driven for elevating and weighing the grain into sacks.

Electrical Plant.

The generating plant, which provides the electrical energy for the electric lighting of the different sheds, and for the electric motors in the same, is placed in the western block. It consists at present of a Babcock Wilcox water tube boiler, worked at 180 lbs. pressure per square inch. This boiler supplies steam to one of Belliss's two-crank compound engines. The three-phase generator is coupled direct to this engine, which is capable of giving 180 I.H.P. at 375 revolutions. This alternator is of the Oerlikon induction type, such as are now being manufactured by the General Electric Company at Manchester.

In this alternator both the electric circuits are stationary, and only the inductor revolves. The section of this alternator (fig. 1) shows the arrangements of the electric and magnetic circuits. The exciting coil, X, is supported by the main casting of the machine, and induces a flow of magnetic lines as indicated by the arrows. The armature cores, A A, are built up of laminated iron plates to form complete cylinders, and the armature conductors are placed in tunnels left in the cores near the inner circumference. The other half of the magnetic circuit consists of a series of laminated projections, K K, securely bolted and dovetailed into the revolving centre. There are in the present machine eight of these laminated blocks or keepers placed at intervals round each end of the revolving centre, B. The magnetic resistance to the flow of magnetic lines is thus a constant for every position of revolving keepers. The only difference made, as this part revolves, is in the positions at which the flux leaves the armature core, A.

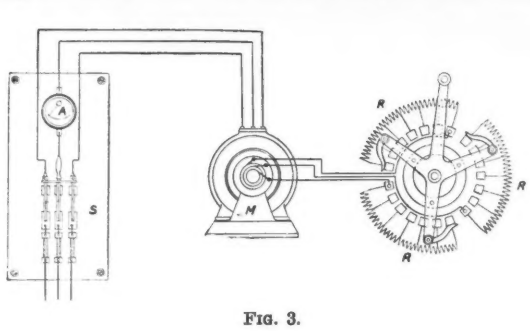


Fig. 3.

This core is provided with eight sets of bars for each phase. The conductors of one phase are equally spaced at intervals round the inner circumference of the core, A, and

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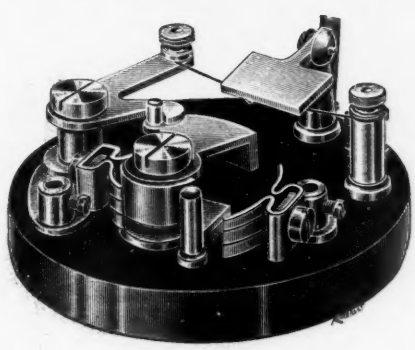
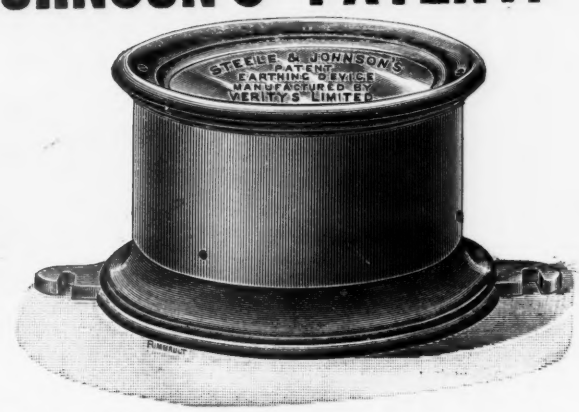
STEELE AND JOHNSON'S PATENT.





No. E.S. 4,380.

Messrs. VERITYS, LIMITED, are Sole Manufacturers of the above Earthing Device, and will be pleased to supply the fullest information on receipt of enquiries. This form of protector, which has only just been placed upon the market, has been inspected and highly approved by a few leading consulting engineers, high tension experts, and others. Results of important tests will be published shortly.

Some of the more important advantages claimed for the Steele & Johnson Patent are here detailed:—

(i.) Its action does not depend upon fine adjustment. The sparking distance is predetermined, and any ordinary fuse wire can be used, though each instrument contains a reel of wire ready for use.

(ii.) It does not depend upon static charges of electricity.

(iii.) The provision of a glass front makes it possible to inspect the instrument without removing the cover.

(iv.) It is not a lightning arrester.

8225—6

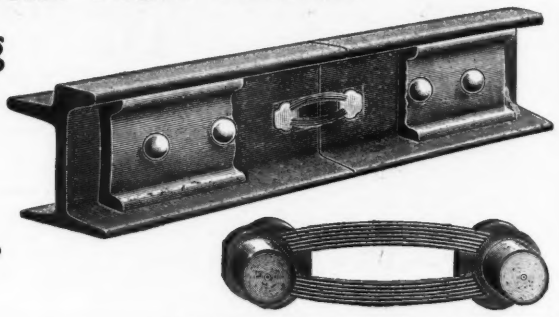
THE PROTECTED RAIL BOND

PLACED UNDER THE FISH PLATE.

Flexible to Vibration and Yielding to Contraction and Expansion.

SOLID COPPER TERMINALS CAST-WELDED ON TO COPPER WIRES.

We furnish Screw Welders for Fastening Bond to the Rail. Send for Catalogue and Prices.



COMMUTATOR SEGMENTS.

DROP FORGED AND ROLL DROP.

ALL STYLES AND SIZES.

THE FOREST CITY ELECTRIC CO.

Main Office and Factory, CLEVELAND, OHIO, U.S.A.

Cable Address:—"ROLLDROP." **Foreign Catalogue in 5 Languages.**

THE

"NATIONAL" GAS AND OIL ENGINES.

Improved "Otto"

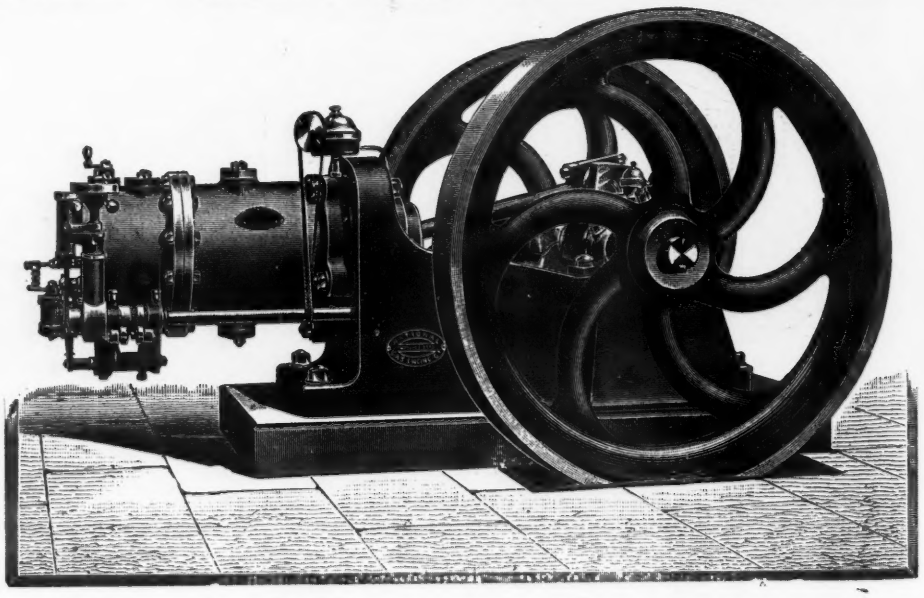
Simple.

Silent.

Economical.

Reliable.

Thousands at work.



ENGINES SPECIALLY CONSTRUCTED FOR ELECTRIC LIGHT.
SELF-STARTERS TO ALL LARGE SIZES. ONE HUNDRED ALWAYS IN PROCESS.

Write for Testimonials and Prices to the

"NATIONAL" GAS ENGINE CO., Ltd.,

ASHTON-UNDER-LYNE.

a817

THE ELECTRIC CONSTRUCTION COMPANY, Ltd.,

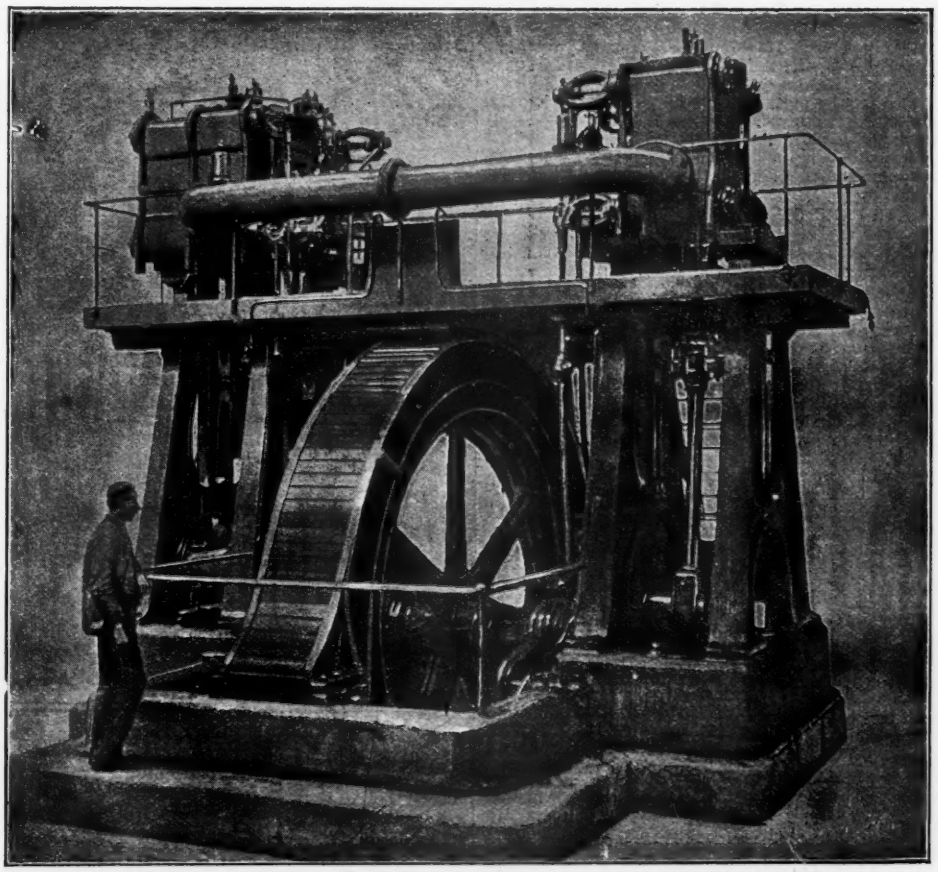
Telegraphic Address:
"ELECTRIC, WOLVERHAMPTON."
Telephone No. 7,075.

WOLVERHAMPTON,

MANUFACTURERS OF EVERY DESCRIPTION OF ELECTRIC POWER PLANT, ARC LAMPS, SWITCHES, &c.,

Contractors to H.M. War Office, Admiralty, &c.

HALIFAX CORPORATION ELECTRIC LIGHT STATION.



350 KILOWATT FLY-WHEEL ALTERNATOR.

The Alternator illustrated above has the fly-wheel mounted direct on the engine shaft, the field magnets being fixed to the rim of the wheel and excited by means of a single coil. The Armature Core is composed of 38 segments, each having a coil wound through slots. The engine manufactured by Pollit and Wigzell, Sowerby Bridge, is of the vertical compound condensing type with special Corliss valve gear, giving 600 I.H.P. at 137 revolutions.

Combined Efficiency at Full Load ... ... 82 per cent.
Combined Efficiency at Half Load ... ... 72 per cent.

Periodicity 87 per Second.

London Office: DASHWOOD HOUSE, 9, NEW BROAD ST., E.C.

Telegraphic Address:—"CONCORDANCE, LONDON." TELEPHONE No. 11,781.

The LIST will OPEN on THURSDAY, July 22nd, 1897, at 10 a.m., and CLOSE for both Town and Country on or before SATURDAY, July 24th, 1897.

THE NATIONAL ELECTRIC FREE WIRING COMPANY, LIMITED.—Incorporated under the Companies Acts. Capital £250,000, divided into 250,000 Ordinary Shares of £1 each, of which there are NOW OFFERED for SUBSCRIPTION 235,000 SHARES—£235,000—the balance being retained to provide the Shares (deferred as to dividends, as stated in the full prospectus) to be taken by the Vendors in part payment of purchase money. The Shares will be payable as follows:—On Application 2s. 6d. per share; on Allotment 2s. 6d. per share; and the balance in calls of not more than 5s. each, at intervals of not less than two months.

DIRECTORS.

R. Stewart Bain, C.A., General Manager of the London Electric Supply Corporation, Limited.

William R. Davies, Director of the House-to-House Electric Supply Company, Limited.

George Ellis, J.P., Director of South London Electric Supply Co., Ltd., Chairman of the Portsmouth Electric Lighting Committee.

James T. Jervis, M.Inst.C.E., F.R.G.S., Director of the Notting Hill Electric Lighting Committee.

J. W. Swan, F.R.S., Director of the Edison & Swan United Electric Light Company, Limited.

BANKERS—Coutts & Co., 59, Strand, London, W.C.

BROKERS—James Capel & Co., 31, Throgmorton Street, E.C.

SOLICITORS

For the Company: Deacon, Gibson, Medcalf & Goddard, 9, Great St. Helens, London, E.C.

For the Vendors: F. J. Leslie & Co., 15, Union Court, Liverpool.

AUDITORS—Monkhouse, Stoneham & Co., Chartered Accountants, 28, St. Swithin's Lane, London, E.C.

SECRETARY AND OFFICES (*pro tem.*)—H. J. Nisbett, 11, Charing Cross Road, London, W.C.

ABRIDGED PROSPECTUS.

OBJECTS.

This Company has been formed for the purpose of carrying out the wiring and fitting of premises for the Electric Light in consideration of an annual payment.

It is well known that the great obstacle in the way of a largely extended use of electricity in this country is the heavy outlay entailed upon the consumer for the wiring and fittings. This obstacle will now be entirely removed, as a would-be consumer of electricity can have his premises completely fitted up by this Company without any initial charge whatever.

OPTION OF PURCHASE.

The agreements with the Supply Authorities provide an option of purchase on the part of the consumer or the authorities, after a fixed period, on equitable terms.

SUMMARY OF ADVANTAGES.

It will be seen that the main advantages of the system are:

1. It is within the power of any occupier in a district worked by this Company to have electric light without initial outlay.

2. The Supply Authorities will collect the charge for wiring with that for the light itself, so that this Company will have no expense of collection.

3. The working capital of the Company will be expended in work producing an immediate return, as each installation, when completed, will immediately become profit earning.

4. The Company will commence a remunerative business at once, without passing through the experimental stage.

This Company will acquire the contracts, licenses, stock, plant, goodwill, and other assets, except cash balances, of the Electric Free Wiring Syndicate, Limited, which was formed for the purpose of fully testing the working of the system in the District of Wallasey, in Cheshire, where the first contract for Free Wiring was made with the District Council.

BUSINESS ALREADY IN HAND.

The Syndicate have arranged terms of contracts for Free Wiring with—The London Electric Supply Corporation, Limited; the St. James's and Pall Mall Electric Supply Company, Limited; the Notting Hill Electric Supply Company, Limited; the South London Electric Supply Corporation, Limited, the Corporation of West Ham; the Shoreditch Vestry; the Corporation of Worcester; the Corporation of Blackpool; and the Wallasey District Council.

ESTIMATE OF PROFITS.

The revenue derived by the Company, being a charge per unit of electricity passing the Supply Authorities' meter, will naturally depend upon the amount of electricity consumed per lamp, but the agreements with the London Companies provide for a minimum payment to this Company at the rate of 1s. per annum for each 8-candle power lamp, or its equivalent installed.

It is estimated that, after making provision for payment of the cash consideration to the Vendors, equipment of showrooms and other necessary initial expenditure, the Company will, from this issue, have sufficient available capital for the equipment of 266,600 lamps of 16 candle-power, or their equivalent, at an average cost of not more than 15s. per lamp. If this outlay were to yield only the minimum return mentioned above at the rate of 1s. per 8 candle-power lamp, the revenue of the Company would thus be £26,660

Deducting from this the general management expenses, including Directors' fees, estimated at 3,500

There would remain a balance of £23 160

Available for depreciation, reserve fund and dividend.

A further revenue to the Company may be expected from sales of lamps for renewals, the supply of higher class fittings, and the wiring of premises for immediate cash in those cases in which customers prefer that method of payment.

Applications for shares should be made on the form accompanying the prospectus, or on the form appended to the newspaper advertisement, and forwarded to the bankers of the Company, together with the deposit payable on application.

Full Prospectuses and Forms of Application for Shares may be obtained from the Bankers, Brokers, Auditors, or Solicitors, or at the Office of the Company.

July 19th, 1897. 182

THE

ZURICH

INCANDESCENCE

LAMP COMPANY

47, VICTORIA STREET,

LONDON, S.W.

LARGEST MAKERS

OF

HIGH VOLTAGE LAMPS

IN THE WORLD.

"Stearn"

High Voltage

Lamps

THOUSANDS OF LAMPS

(200 TO 230 VOLTS)

ALWAYS KEPT IN STOCK.

PROMPT DELIVERY.

NO WAITING.

8811

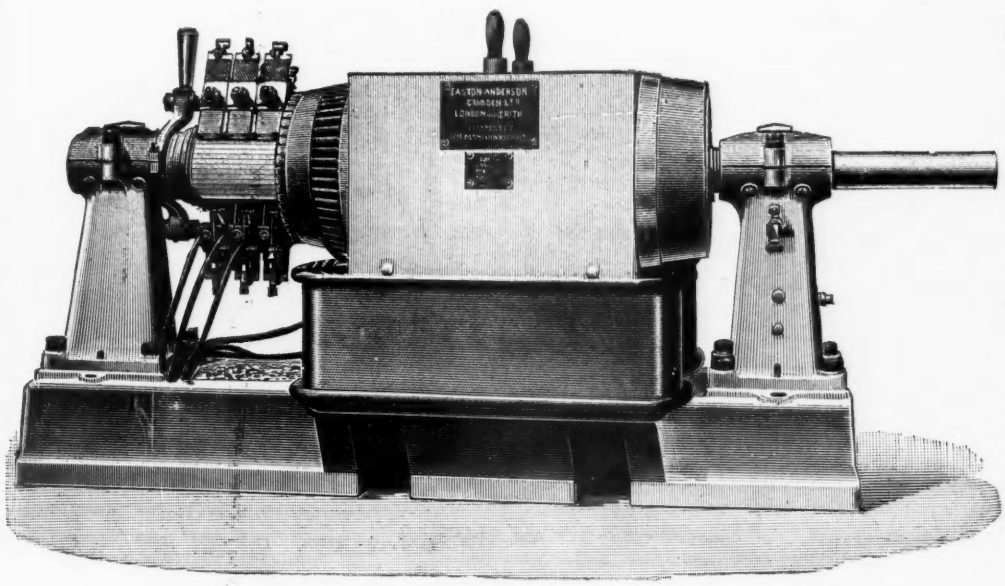
EASTON, ANDERSON & GOOLDEN, LIMITED.

HEAD OFFICE:—ERITH IRONWORKS, ERITH, Kent.
Telegrams:—"EASTONS ERITH." Telephone:—DARTFORD, No. 4.

LONDON:—Broad Sanctuary Chambers, Broad Sanctuary, S.W.
Telegrams:—"EGYPTIAN, LONDON." Telephone:—545 Westminster.

NEWCASTLE-ON-TYNE:—2 St. Nicholas Buildings.

CARDIFF:—Western Mail Buildings



F.D. DYNAMO.

ELECTRIC MINING MACHINERY.

PATENT ENCLOSED MOTORS FOR COLLIERIES.

ELECTRIC COAL CUTTING.

ELECTRIC LIGHT & POWER.

HIGH SPEED ENGINES.

ELECTRIC LIFTS AND CRANES.

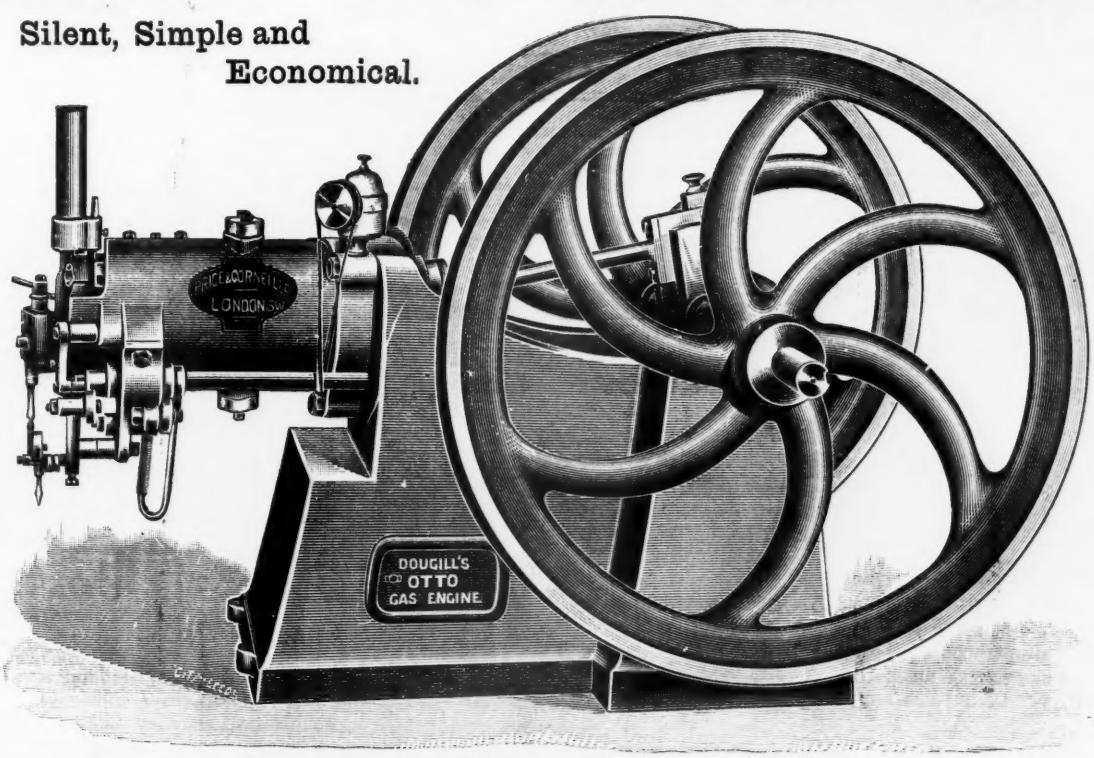
ELECTRIC TRACTION.

BOILERS.

1268

DOUGILL'S "OTTO" GAS & OIL ENGINES

Silent, Simple and Economical.



AWARDED 10 GOLD MEDALS.

PRICE & CORNEILLE, 15, VICTORIA STREET, **LONDON, S.W.**

Telegrams:—"PROCLINO, LONDON."

BROCKIE-PELL ARC LAMP

(LIMITED),

97, Queen Victoria Street, LONDON, E C.

Telegrams: "Illuminers, London." Telephone No. "Bank 294.

OWNERS OF THE PATENTS AND SOLE MAKERS

of the well-known

BROCKIE-PELL ARC LAMP

as used by

H.M. GOVERNMENT in numerous Departments (over 1,000 lamps).

COLONIAL and FOREIGN GOVERNMENTS. | UPWARDS of 20 RAILWAYS.

OVER 40 CORPORATIONS and VESTRIES. | OVER 50 ELECTRICITY SUPPLY STATIONS

And by Docks, Harbours Mines, Factories, Shops, Theatres, Exhibitions, &c., &c., all over the world.

NOTICE.

On and after 1st June, 1897, all lamps issued by this Company will bear our Trade Mark

"BROCHIPEL"

ECONOMY IN FUEL.

The CAMBRIDGE ELECTRIC SUPPLY CO., LTD.,
Thompson's Lane, Cambridge, May 5th, 1897.

Messrs. MELDRUM BROS., MANCHESTER.

YOUR FURNACES.

Dear Sirs,—At the end of the month's trial, April 30th, you will be glad to hear that your furnace has fulfilled the guarantee: the amount per unit generated in coal has been reduced by 17½ per cent., and per unit sold 30 per cent. The absence of smoke is very marked, excepting a slight amount when the boiler has been forced hard: we have on several occasions obtained an evaporation of over 8,000 lbs. per hour (boiler being two-flue Lancs., 30 ft. by 7 ft. 6 in.). There is little doubt that the Board at their next meeting will decide to add these furnaces to the two remaining boilers.

(Signed) JOHN H. BARKER.

Note.—Since the above letter was written we have received the order for the two remaining boilers.

MORE STEAM.

LESS COST.

LESS SMOKE.

5000 WORKING.

WRITE FOR CATALOGUE AND OTHER TESTIMONIALS.

MELDRUM BROS.,

Atlantic Works,

MANCHESTER.

ALSO AT—

London.	Liverpool.
Leeds.	Birmingham.
Glasgow.	Newcastle on-Tyne.
Paris.	New York.
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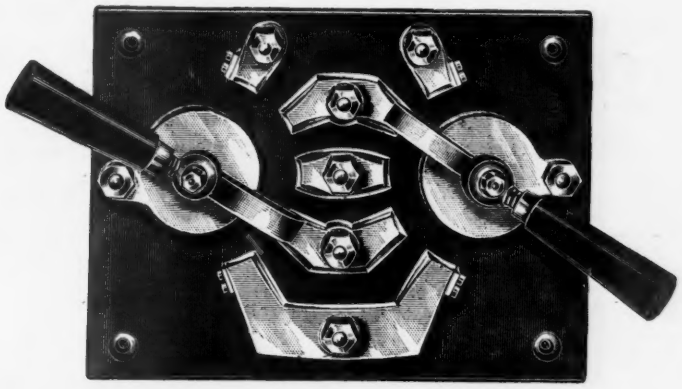
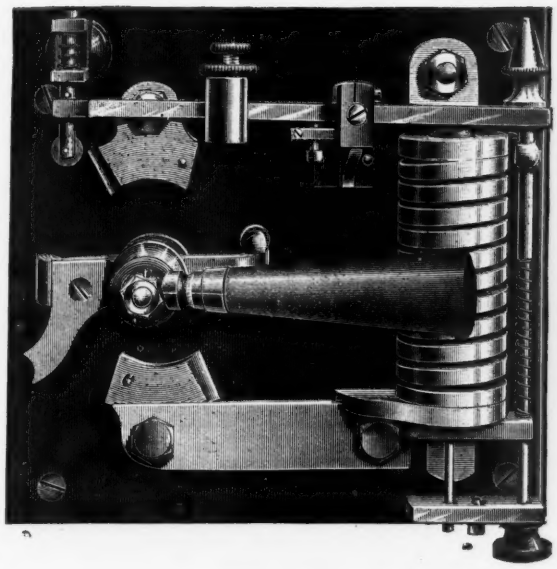
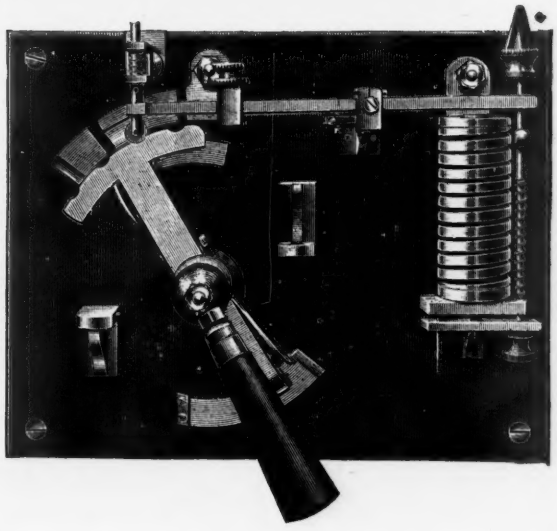
8610







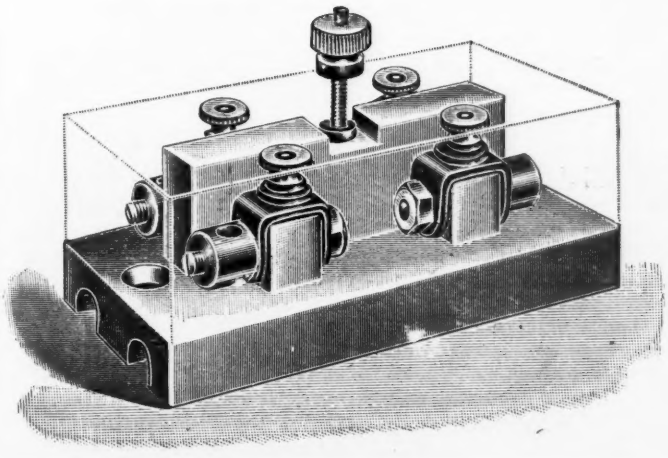
FOR PRICES AND PARTICULARS

APPLY TO THE

ACTUAL MANUFACTURERS,

WILLIAMSON & JOSEPH, Ltd.,

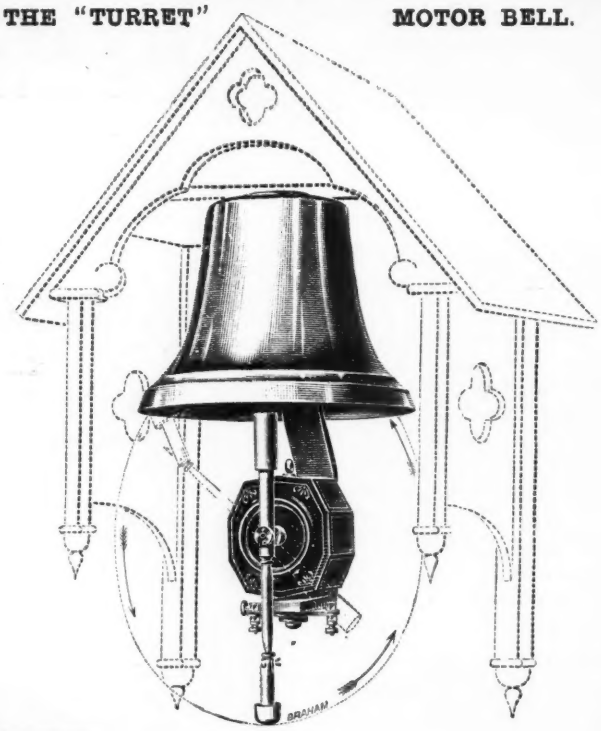
92, QUEEN VICTORIA STREET
LONDON, E.C.;
And Tower Bridge Electrical Works.



THE

GENERAL ELECTRIC CO., LD.,

THE "TURRET" MOTOR BELL.



ELECTRIC BELLS for Indoor and Outdoor use.

SINGLE & DOUBLE BOBBIN BRACKET BELLS.

CHIME BELLS (in sets of distinguishing tones).

MAGNETO BELLS.

IRON MINING AND OUTDOOR BELLS.

ELECTRIC INDICATORS, with Mechanical or Electrical Replace.

PENDULUM INDICATORS.

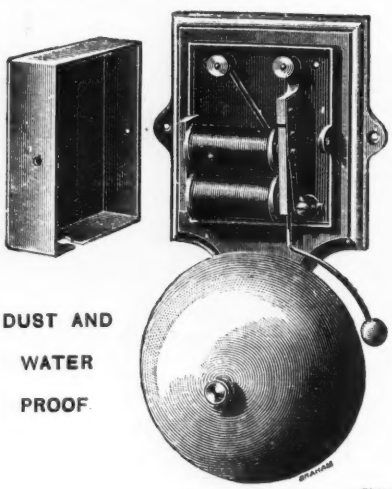
RELAYS.

TREMBLING AND SINGLE STROKE BELLS.

FIRE ALARMS.

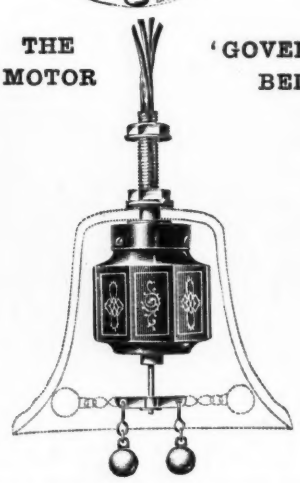
BURGLAR ALARMS.

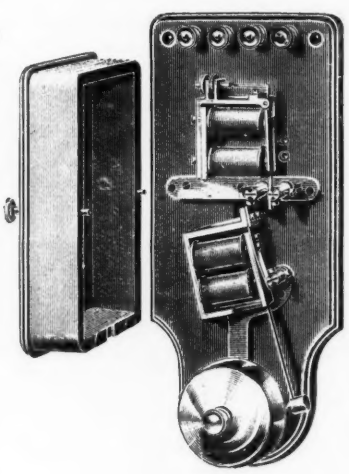
COMBINED BELLS with RELAYS for long distance work.



DUST AND WATER PROOF

THE MOTOR 'GOVERNOR" BELL.





PATENT APPLIED FOR.

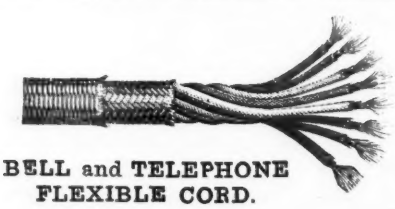
NORMAL POSITION.

NEW PATENT

Now introduced in Barrel Pushes. No extra charges.

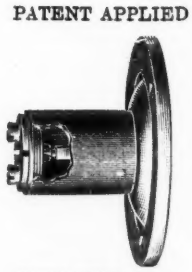
ELECTRIC BELL and TELEPHONE WIRE.

MULTIPLE TELEPHONE CABLE.



BELL and TELEPHONE FLEXIBLE CORD.

PATENT APPLIED FOR.



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RUBBING CONTACT.

Ensuring a perfect rubbing contact. Prices as in 11th Edition Bell Catalogue.

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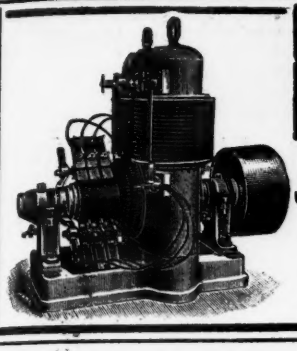
Works— Peel Works, Adelphi, SALFORD. Brook Green, HAMMERSMITH. CLERKENWELL.

Branches— 45, Chapel Street, Manchester. 71, Waterloo Street, Glasgow. 39, Corporation Street, Birmingham. 13, Westgate Road, Newcastle-on-Tyne.



"CASTLE" SLOW SPEED. HIGH EFFICIENCY.

J. H. HOLMES & CO., NEWCASTLE-ON-TYNE, AND 17 SOHO SQUARE W.

DYNAMOS

2603

THE ELECTRICAL REVIEW.

PUBLISHED EVERY FRIDAY, PRICE 4d.

Office: 22, PATERNOSTER ROW LONDON.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY

NOTICE TO ADVERTISERS.

The following are the LATEST times up to which Advertisements can be received for publication in current week's issue:—

New Advertisements, or Alterations to existing ones, Wednesday 2 p.m.
Small Announcements for middle pages, Thursday 2 p.m.

TELEPHONE No. 15,077 Telegrams: "INDICES," LONDON.

WHEATLEY KIRK, PRICE & GOULTY

(ESTABLISHED 1805).

Electrical Auctioneers, Valuers,

AND ARBITRATORS.

Average Annual Valuations exceed £1,500,000 Sterling.

49, QUEEN VICTORIA STREET, LONDON E.C.

a2391

The United Gutta-Percha and India-Rubber Co., Ltd., in Liquidation.

At Craigpark Works, Townmill Road, Glasgow, on Thursday and Friday, August 5th and 6th.

IMPORTANT SALE OF

THE WHOLE VALUABLE MODERN WORKING PLANT MACHINERY AND STOCK

BELONGING TO THIS COMPANY, BY AUCTION.

J. AND R. EDMISTON are instructed by the Liquidator, D. S. Carson, Esq., C.A., to Sell this Valuable Plant and Stock on Thursday and Friday, August 5th and 6th, at 12 noon each day.

Catalogues in preparation.

Order of Sale—Stock of Raw Materials and Finished Goods on Thursday, Working Plant on Friday.

J. & R. EDMISTON, Auctioneers, 41, West Nile Street, Glasgow. 1325

CHEAP PREPAID ADVERTISEMENTS,

Relating to *Situations Vacant, Situations Wanted, Businesses Wanted, Businesses for Sale, Patents for Sale, Specific Articles of any kind Wanted, or for Sale or Exchange, are inserted at the rate of* ONE PENNY *Per Word* (*minimum* 1s.).

Three consecutive Insertions for the Price for Two.

*** This Scale does not apply to Trade Advertisements, terms for which can be had on application.

SITUATIONS VACANT.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

Original Testimonials should never be sent.

ASSISTANT, young, wanted, for meter testing in London.—Apply 1330, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1330

ELECTRICAL INDICATORS.—Wanted, Gentlemen having engineering knowledge and connections, to introduce and assist in establishing business with a new system for registering quantities, movements, and speed. The invention is capable of wide application, and has been already proved on electric, water, and gas meters, as well as machinery, carriages, and registering numbers passing turnstiles.—Apply by letter only, with terms asked, to "INDICATOR," care of Messrs. Street, 30, Cornhill, London. 1312

MECHANICS wanted, with electrical experience.—Apply 34, Gerrard Street, Soho. 1317

VULCANITE.

HARBURG INDIA-RUBBER C. COMPANY.

London Warehouse: F. WINTER, 138, London Wall, Wood St., E.C.

EBONITE. 1710

PREMIUM PUPILS.—Large electrical manufacturing works, near London, have several vacancies.—Address 1,278, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1278

WANTED.—Competent Wiremen capable of taking in hand small installations.—Apply at once, giving full particulars, to S. H. HEYWOOD, Ducie Street, London Rd., Manchester. 1324

WANTED.—Working Electrician who has had practical experience in testing installations and in repairing and running gas and steam engines, to join inspecting and repairing staff of a large firm of electrical contractors in London.—Apply by letter only, stating age, experience, and wages required, to 1,327, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1327

WANTED Immediately, good Armature Winder. — Send references, age, &c., to 1,320, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1320

WANTED, for first-class electric supply house, experienced Stock-keeper, and to attend to buying department and cost book.—Letters only, "PERMANENCY," ELECTRICAL REVIEW, 22, Paternoster Row, London. 1333

WANTED.—Draughtsman, fully capable of making all the necessary working and detail drawings for an electric light station, under the direction of an engineer. Preference will be given to one having a knowledge of electricity, and to act as electrical clerk of works, over the mains, apparatus, &c. Applicants to state age, experience, salary required, and to enclose not less than two copy testimonials.—Address 1,310, ELECTRICAL REVIEW, 22, Paternoster Row, London, not later than July 28th 1310

SITUATIONS WANTED.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

ELECTRICIAN (young) wants situation to take whole or part charge of electric light installation, or as an Assistant in central station, do own repairs, good armature winder.—"W. W.," 31, Ossington Street, Bayswater, W. 1349

ENGINEER requires situation at electric supply company, to take charge of engines, boilers, and their repairs, 9 years' experience with high-speed electric engines, good references.—"H. G. G.," 29, Victoria Road, Harborne, Birmingham. 1355

ELECTRICIAN (22) three years as pupil in good firm, desiring further experience, seeks situation with a consulting engineer or works offices; experience dynamo and switchboard design and general work. Highest certificates; good draughtsman.—Address "Z" 19, Cedar Gardens. 1332

ELECTRICAL ENGINEER (24) wants responsible post, home or abroad, experienced in installation work, dynamo manufacture, accumulators, &c.—1,313, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1313

FOREMAN seeks situation in cable works; 20 years' experience. Good testimonials.—Address "TILL," Griffin Hotel, Lower Broughton Road, Manchester. 1329

WIREMAN, Carpenter, wants work, practical, fix well; testimonials.—600, Harrow Road, W. 1316

WIREMAN (29), late R.N., seeks employment; could take charge small plant; references.—Address, FRY, Horsted Keynes, Sussex. 1991

[*Continued on next page.*]

ARTICLES FOR SALE AND WANTED, PARTNERSHIPS, &c.

Where Advertisements are to be answered to a given number, letter or nom de plume at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

ACCUMULATOR RECHARGING.—Peto & Radford, Ltd., having increased their storage battery plant, are now prepared to make additional contracts for recharging accumulators of all sizes. Power available night and day. Telephone No. 6,994.—PETO & RADFORD, LTD, 57B, Hatton Garden, London, E.C. 8480

ACCUMULATOR Charging.—C. H. Cathcart & Co., having plant specially adapted for this purpose, charge cells of all sizes promptly, thoroughly, and cheaply. Terms on application. Accumulators on hire for temporary lighting, experimental uses, &c.—3, Dorset Buildings, Salisbury Square, Fleet Street, E.C. (Telephone No. 65,266). 7345

ELECTRICAL ENGINEER returning to Johannesburg would like to meet with same, about 28, with knowledge of estimating and little capital.—"E H. G, 30, Preston Road, Brighton. 1328

FOR SALE.—Private plant, including 4 H.P. Crossley gas engine, 100-light 60-volt dynamo, link belt and set of 27 accumulators. The whole in working order.—Apply personally, 104, George Street, East Croydon. 1321

MOTOR, direct, 50 volt, about ¾ H.P. wanted, E.C.C. preferred. —State price and particulars, 1,257, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1257

NEWLY-BUILT Premises to Let in Bury Street, Fulham Road, Chelsea, very suitable as charging station for motor-car cells, or for small workshop. Electric supply laid on.—For further particulars, apply CHELSEA ELECTRICITY SUPPLY CO, 19, Cadogan Gardens, S.W. 1252

PLATINUM in any form and quantity, purchased at highest prices by DERBY & Co., 44, Clerkenwell Road, London. 6523

SOUTH AFRICAN AGENCIES.—A well-established Johannesburg firm of mining engineers will consider offers of sole agencies for high-class electrical machinery and specialities.—1,246, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1246

WANTED.—Old scrap cable, wire, &c.; any quantity bought. —EDEY & Co, 29, Ludgate Hill. 1256

WANTED, Electric Lamp Tops and Scrap Platinum.—EDEY AND Co., 256, Ferndale Road, Brixton. a1008

WANTED, on hire, for three days in the Midlands, three 10-ampere arc lamps with dynamo for same, and about 500 yards of conductor.—1,319, ELECTRICAL REVIEW, 22, Paternoster Row, London. 1319

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SMALL MODEL DYNAMOS,

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Makers of all kinds of Electrical Plant, Hubert Street Works, Leeds Road, Bradford
See our Page Advertisement First Friday in each month.

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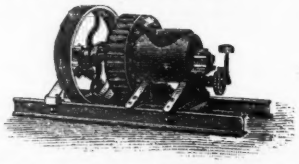

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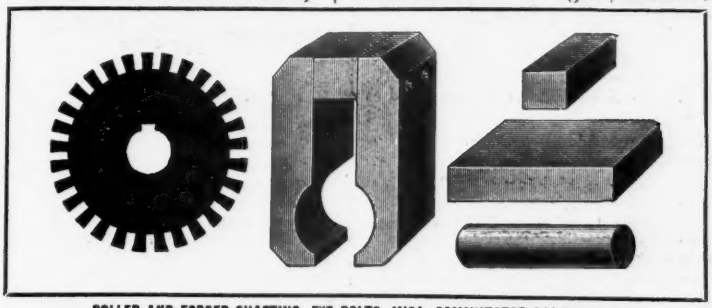

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Official Notices.

CITY OF CARLISLE.

CENTRAL ELECTRIC LIGHTING STATION.

THE CORPORATION OF CARLISLE invite Tenders for the following work in connection with their electric lighting station in Carlisle.

Contract No. 1.—
Boilers (Lancashire) and Mechanical Stokers.

Contract No. 2.—
Engines, Dynamos, Condensers, Pumps, &c., Steam, Exhaust, Feed and Drain Pipes.

Contract No. 3.—
Storage Battery.

Contract No. 4.—
Section A.—Switchboard for Dynamos and Feeders.
Section B.—Boosters and Switchboard for Batteries and Boosters.

Contract No. 5.—
Arc Lamps and their Erection.

Contract No. 6.—
Feeders, Mains, and Arc Lamp Leads.

In Contract No. 2, it is a condition that the dynamo makers must have already constructed dynamos of at least 100 units capacity.

Copies of any of the specifications, with forms of tender and general conditions, can be obtained, after Wednesday, the 28th instant, on payment of One Guinea for each (to be returned on receipt by the Corporation of a *bonâ fide* tender), at the office of Mr. HENRY C. MARKS, City Surveyor, Fisher Street, Carlisle, or Dr. A. B. W. KENNEDY, 17, Victoria Street, Westminster, London, S.W.

The Corporation do not bind themselves to accept the lowest or any tender.

Tenders on the prescribed form, enclosed separately in sealed envelopes, and marked "Electric Lighting," Tender for Contract No. ( ), must be delivered at the Office of the City Surveyor, Carlisle, not later than Thursday, August 12th next.

By order,
A. H. COLLINGWOOD,
Town Clerk.

Town Clerk's Office,
Carlisle, *July 21st*, 1897. 1926

Official Notices.

PORT ELIZABETH MUNICIPALITY.

TENDERS FOR ELECTRIC LIGHTING.

THE TOWN COUNCIL of Port Elizabeth, Cape Colony, are prepared to receive tenders for Lighting the Streets and Municipal Buildings of Port Elizabeth by Electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, &c., for terms of 5, 15, 20, 25, or 30 years respectively.

The number of inhabitants of the town is about 30,000, of whom about 20,000 are Europeans.

There are approximately about 54 miles of streets in the town, as follows:—Main thoroughfares, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16 candle-power.

The Municipal Buildings consist of Town Hall, Municipal Offices, Morning Market, Feather Market, Wool Market, and Museum.

The main streets are to be lighted by arc lamps and the side streets and municipal buildings by incandescent lamps.

The tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to.

The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionnaires shall be subject to the approval of the Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, &c., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains.

Tenders endorsed "Port Elizabeth Electric Lighting," should be delivered to the Agents of the Municipality, Messrs. DAVIS AND SOPER, No. 54, St. Mary Axe, London, E.C. (from whom further information may be obtained), on or before the 21st September, 1897.

The Council do not bind themselves to accept the lowest or any tender.

By Order,
S. MANDY,
Acting Town Clerk.

Town Office, Port Elizabeth. 1923

[*Continued on next Page*]

Official Notices.

COUNTY BOROUGH OF SUNDERLAND.

ELECTRIC LIGHTING.

To Electrical Manufacturers and Ironfounders.

THE CORPORATION OF SUNDERLAND are prepared to receive Tenders for:—

1. Combined Arc Lamp and Trolley Poles.
2. Arc Lamps and Accessories.

Specifications can be obtained from Mr. JOHN F. C. SNELL, A.M.I.C.E., Borough Electrical Engineer, Dunning Street, at his office, on payment of a deposit of £1 1s. on each of the two specifications, which will be returned on receipt of *bonâ fide* tenders.

The persons or firms whose tenders are accepted will be expected to pay the rate of wages to workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed.

Sealed Tenders, addressed "To the Chairman of the Highways Committee," Town Hall, Sunderland, must be sent to my office, on or before WEDNESDAY, JULY 28th, 1897, and not later than 12 o'clock noon on that day. Tenders to be submitted separately, and endorsed "Tender for Lamp and Trolley Poles," and "Tender for Arc Lamps," respectively.

The Corporation do not bind themselves to accept the lowest or any tender.

By Order,
FRAS. M. BOWEY,
Town Clerk.

Town Hall, Sunderland,
July 13th, 1897.

1399

BOROUGH OF DERBY.

DERBY CORPORATION ELECTRIC LIGHTING.

THE CORPORATION are prepared to receive Tenders for the Supply and Laying of High Tension Cables, Junction Boxes, Cable and Hauling Winch Section "A," Transformer Boxes, Switches, Safety Fuses, &c., Section "B," in the Borough of Derby.

Specification and form of tender may be had on deposit of £1 1s. (which will be returned on receipt of a *bonâ fide* tender), from Mr. J. E. STEWART, Engineer, Electric Lighting Station, Derby, on and after Monday, July 19th, 1897.

Tenders endorsed "Electric Lighting Tender for Cables, &c.," to be sent to the undersigned, not later than 12 noon on Monday, July 26th, 1897.

The lowest or any tender will not necessarily be accepted.

H. F. GADSBY,
Town Clerk.

Town Hall, Derby,
July 14th, 1897.

1369

PARISH OF ST. MARY, ISLINGTON.

TENDERS are invited for an installation of Electric Light at the Caledonian Road Baths, Caledonian Road, N.

Specifications and particulars may be obtained from Mr. A. Hessell Tiltman, architect, 6, John Street, Bedford Row, W.C., on payment of a sum of Two Guineas, which will be returned on receipt of a *bona-fide* Tender.

Persons tendering must annex to their Tenders a schedule of wages relating to their trade, and will be required to make a declaration that they do and will during the continuance of any Contract they may enter into with the Vestry, continue to pay the Trade Union rates of wages as in practice obtain, and observe the conditions and hours of labour prevalent among the several classes of labour they may employ.

They will be required to enter into a Contract, and to find one surety for the due execution of the work, and they must also agree not to sub-let, or assign over their Contract, or any partnership, without the previous consent of the Vestry.

Tenders, sealed and endorsed, "Tender for Electric Light Installation at Caledonian Road Baths," must be sent to the undersigned at the Vestry Hall, Upper Street, N., not later than 12 o'clock noon on Thursday, August 5th, 1897.

WM. F. DEWEY,
Vestry Clerk.

21st July, 1897.

1331

THE MARKETS AND FAIRS COMMITTEE
OF
THE CORPORATION OF THE CITY OF BIRMINGHAM

REQUIRE the services of a thoroughly competent Man to take charge of the electric lighting installation at the New Meat Market, comprising three 85-H.P. gas engines, dynamos, storage batteries, incandescent lamps, arc lamps, and the system of concentric wiring in connection therewith.

Also to take charge of two Lancashire steam boilers and the steam and hot and cold water systems in connection with the buildings.

No one need apply who has not had charge of an installation of a similar character.

Wages to commence at 50s. per week, rising to a maximum to be determined by the committee.

Applications by letter in own handwriting, accompanied by three recent testimonials as to character, sobriety, and knowledge of work, and stating age and past experience, must be sent by post not later than AUGUST 5th, 1897, addressed to the CLERK to the Markets and Fairs Committee, Council House, Birmingham.

1315

Educational Notices.

KING'S COLLEGE, LONDON.

ENGINEERING, ARCHITECTURE, AND APPLIED SCIENCE DIVISION OF THE FACULTY OF SCIENCE.

Michaelmas Term Commences Thursday, September 30th.

THE full Curriculum for the College Associateship in Mechanical, Civil, or Electrical Engineering, Architecture, Chemical Manufactures, and Metallurgy, extends over a period of three years. A shorter course of two years qualifies for the Certificate of Engineering.

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ELECTRICAL ENGINEERING, J. HOPKINSON, D.Sc., F.R.S.
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Non-Matriculated Students, or those who, not wishing to attend the whole course, are desirous of studying any particular subject, may attend any of the classes held on payment of the specified fees.

EVENING CLASSES

are held for Civil, Mechanical and Electrical Engineering, Workshop Practice, Architecture and Building Construction, Drawing, Metallurgy, Wood Carving, and Science Subjects.

For Prospectuses and all information apply to

THE SECRETARY,

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1334

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PROF. ANDREW GRAY, LL.D., F.R.S., will begin in October next a systematic COURSE OF INSTRUCTION in Electrical Measurement and Practical Electricity. The Physical Laboratory is fully equipped with a Compound Steam Engine, Dynamos, Transformer, Secondary Battery, and the most approved modern Measuring Instruments for all branches of Electrical Engineering.

Laboratory Fees at the rate of £1 1s per Term for six hours per week. Composition Fee for all College Lectures for the Session, £10

Applications for Calendar, Prospectus, and general information to be made to

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1311

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Full particulars of the courses of instruction qualifying for the degrees of the Victoria University, will be forwarded on application.

The SESSION commences on TUESDAY, OCTOBER 5th.

SYDNEY CHAFFERS, *Registrar.*

1318

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This liquid is pronounced by the most eminent Electrical Engineers to be perfect, and the most useful yet known. Commutators thus treated will wear twice as long, and so save expense, besides trouble.

Used by Railways, leading Electric Lighting Companies, and largest Firms in the kingdom.

The proof of its utility is by testing a bottle, which can be had of any **Electrical General Dealing Firms,** *or of the Manufacturer,* **A. L. Bayley, Moor Green, Birmingham.**

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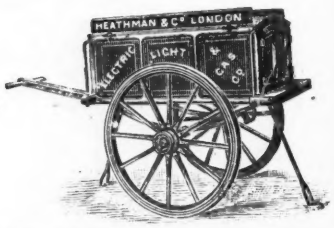

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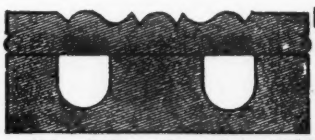

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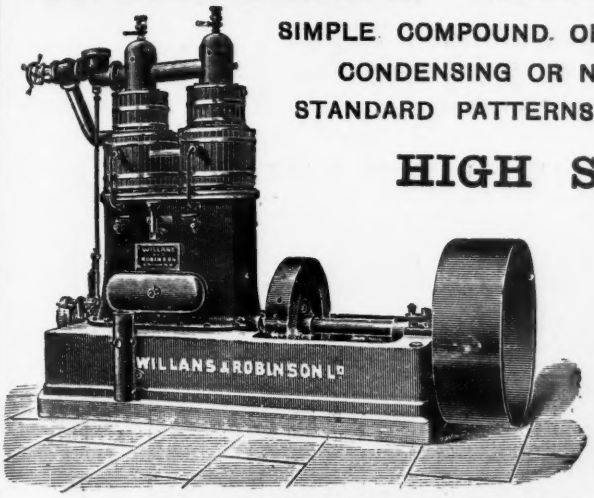

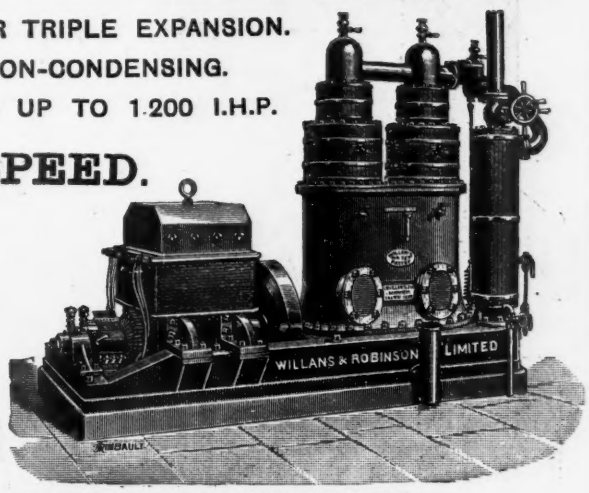

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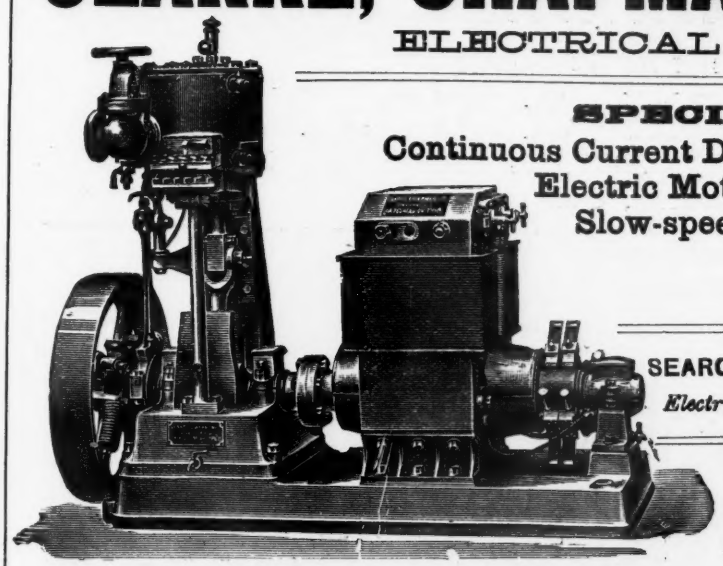

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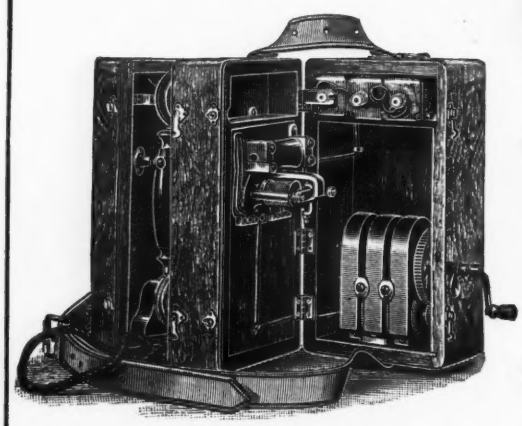

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the action will be more easily understood if one phase is considered by itself. When the keepers, K K, are directly opposite these coils the whole of the flux passes through them, and the zero point on the E.M.F. curve is given.

As the machine revolves, the keepers withdraw the flux from the coils until they have moved so as to be equally spaced between two coils. In this way an alternating E.M.F. is obtained without either of the copper circuits revolving.

The three-phase windings are, of course, spaced round the armature so as to have generated in them E.M.F.'s varying in phase of 120°. The armature bars of each phase, after being connected in series, have one free end connected to a common terminal, and the other is then connected to one of the three terminals of the machine. This gives what is known as the Star method of connection. In the machine at Liverpool, the E.M.F. across any of the armature circuits is 120 volts, which gives 210 volts between either pair of terminals. The excitation for the coil X is obtained from a small direct current dynamo, coupled to an extension of the armature shaft; this exciter is of the internal two-pole type. It is provided with carbon brushes, and gives 50 volts. The combined plant was tested at Messrs. Belliss's works, at Birmingham, during a six-hour run at 15 per cent. overload. The following is a brief *resumé* of the results obtained:—

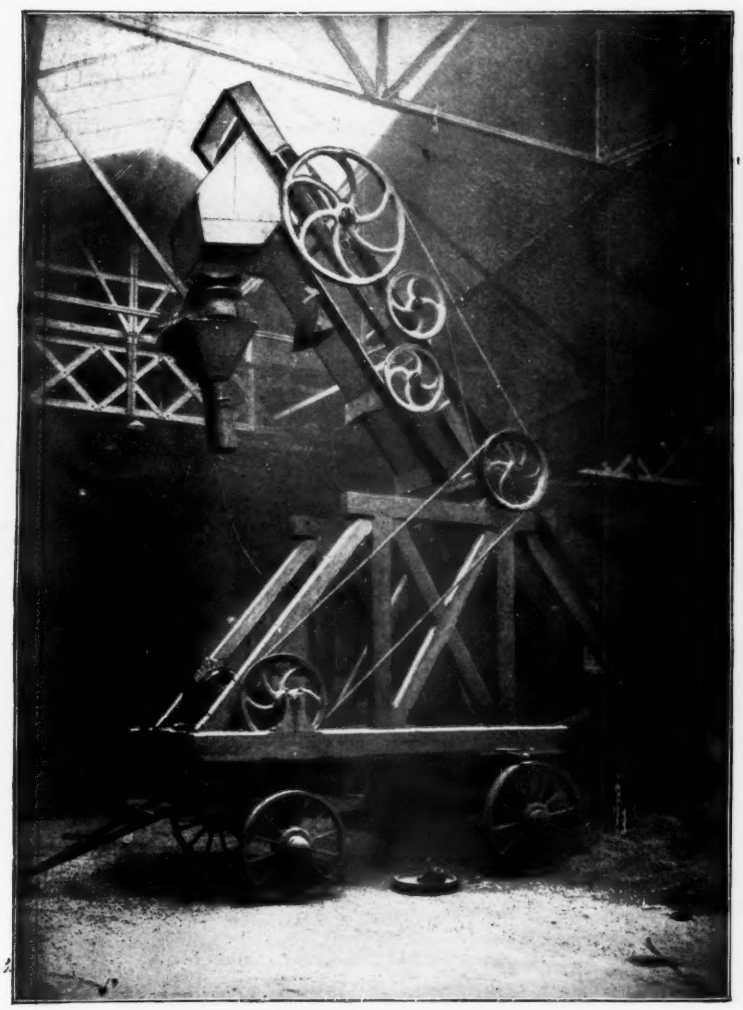


Fig. 5.

Speed, 377 revolutions per minute.

Indicated horse-power, high pressure cylinder		100·3
Low " "		115
Total ...		215·3

The average watts taken from the alternator were 133,000 = 178 E.H.P.

The combined efficiency obtained was therefore equal to $\frac{178}{215·3}$ = 82·6 per cent.

The temperature of the alternator after the six hours run was as follows:—

Air temperature	68 F.
Maximum temperature inside armature ...	117 F. rise 49 F.
" " exciting coil ...	130 F. rise 62 F.

The exciting current at no load was 13 amperes.
" " " at 15 per cent. overload was 16·5 amperes.

Thus, when overloaded, the alternator only requires 0·63 per cent. of its output for excitation.

Assuming the efficiency of the engine to be 90 per cent., the above tests would give a commercial efficiency of 91·5 per cent. for the alternator. The characteristic advantages of this inductor type and alternator are as follows:—

1. Good mechanical construction, as no parts requiring insulation revolve. The moving parts can be designed amply strong.

2. No collecting brushes or revolving contacts are needed, as both the armature and exciting circuits are stationary.

3. The magnetic circuit requires only a small percentage of the output of the machine for excitation.

4. The magnetic circuit has practically constant resistance for all positions of the revolving parts; hence the field is constant, and no wasteful eddy currents are set up in it.

5. The machine is practically noiseless.

6. The winding of the armature conductors inside insulating tubes in the tunnels gives a good insulation resistance.

Thus, while this type of alternator compares favourably with the other types in general use in England, it has the above mechanical and electrical advantages, which are likely to result in smoother working and lower cost of upkeep.

Switchboard.

The three mains from the generator are led to a switchboard, which contains the usual complement of switches. The voltmeter is connected between the common terminal of the three armature circuits and one of the main conductors. The ammeter, indicating the output of the machine, is placed in one of the main conductors, as shown in the diagram of connections, fig. 2. A neat arrangement is provided for keeping the voltage of the machine constant under widely varying loads. A voltmeter, marked C V in the diagram, is arranged with two relay contacts, and a variation of 3 volts from the normal up or down, closes one or other of the relay circuits. The relay acts in the following way:—A one-quarter horse-power motor drives, by means of a countershaft, the two loose portions of the clutch A B, one of the belts between the countershaft, and the clutch is crossed so that the two sides are revolving in opposite directions. The relay coils close the secondary circuits, energising one or other of the electro-magnets of the revolving clutch. This binds one or other of the revolving parts to the shaft D, and causes the contacts on the rheostat to be shifted by a screw gear. In the ordinary working conditions the exciting current is varied between 14½ to 16½ amperes. As there are about 20 contacts in this range, the apparatus can be regulated so as not to hunt. As the engine governs within 2 per cent., this apparatus is chiefly called into play when

the large motor in the elevator tower is started or stopped. The switchboard consists of three white marble slabs, mounted in a handsome polished wood framing. The first vertical slab contains the instruments and switches for the present plant. The central slab contains the automatic regulating instruments, and the third slab is spare.

The omnibus bars are placed on the face of the board at the bottom, and extend across the three panels.

The main cable, leaving the switchboard, consists of a triple concentric lead covered cable of the Callender bitumen type. Each conductor has a sectional area of ·38 square inches. This cable is attached to the walls of the sheds under a projecting brick cornice, by means of hoop iron clip, where the cable leaves the eastern block of buildings to cross the western group of sheds, the cable is carried overhead to meet the wishes of the Dock Commissioners. It is supported for a span of 107 feet from a $\frac{1}{8}$th stranded steel rope. The total weight of cable, steel rope, and clips in this span amount to about $\frac{3}{4}$ of a ton. The cable is then taken to the gallery along which the two main conveyors run, and from thence is tapped for the various circuits. The grain sheds are arranged in groups of three bays, each with a roadway between. Down the centre of each middle bay the power leads are run on substantial wooden planks, supported on the iron roof principles. Plugs, to which flexible leads for motors are attached, are provided every 36 feet.

Each shed is lighted by 32 C.P. lamps fixed to the roof at intervals of about 24 feet. The lamps in each shed are on two circuits, one controlled from either end. The circuits are provided with a liberal allowance of fuses, no more than four lamps being controlled from any switch. All the branch wiring is carried out on the interior conduit system. The armoured tubes are fastened to the surface of the wall, and the insulated wires drawn into these. There are some 102 lamps of 32 candle-power installed, and 93 of 16 candle-power. The general appearance of the work is most neat and workmanlike.

The following motors are now at work in the western block of buildings:—

One 36 horse-power motor, placed in the main elevator tower. This motor drives a gearing for raising and lowering the outside leg of the elevator. This leg, with the gear attached, weighs some 10 tons, and is moved at a rate of 15 feet per minute. The regular work of the motor is to drive the inside and outside elevators, which, as mentioned *before*, are capable of raising 160 tons of grain per hour. This motor is very much overloaded, as may be gathered from the fact that it takes no less than 120 amperes per circuit. It is connected to the main countershaft by means of spur gearing. A raw hide pinion on the motor axle works into a steel wheel on the countershaft. In starting the large amount of dead weight to be accelerated puts a great strain on the motor, it taking 150 amperes for the instant. In spite of these hard conditions, no inconvenience has arisen, but it is doubtful if a direct current motor, similarly overloaded, would give satisfaction.

Two 18 horse-power motors operate the two main conveyors. These motors are also coupled to their work by means of open gearing. These two motors were driving the conveyor belts without any carrying grain when they were inspected. They are, however, well able to bear the load, and the design of the starting resistance is most perfect. The connection used in starting these two motors and the 36 horse-power motor, mentioned above, are shown in fig. 3. The resistance is placed in the rotor circuit, and is gradually short-circuited as the motor gains in speed. Each circuit of the 18 horse-power motor took 22 amperes when the conveyor belt had reached its normal speed. This belt, which is 2 feet 6 inches wide, and about 80 yards long, was accelerated to a speed of 360 feet per minute in the short time of 50 seconds. The steps in the rheostat are so well proportioned that the current never exceeded 30 amperes. When the motors have reached their normal speed of about 960 revolutions, the coils on the rotor are short circuited by means of a clutch arrangement. The collecting brushes are then lifted, and the motor controls itself automatically.

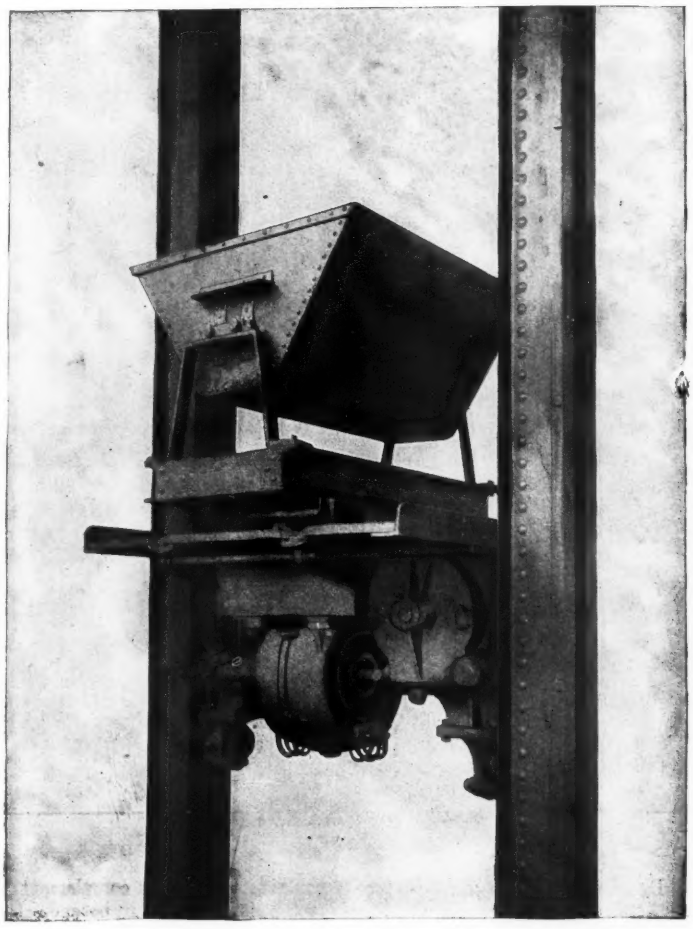


Fig. 6.

Three 5 horse-power motors, mounted on trolleys so as to be readily shifted about the floor, are provided for working the small distributing conveyors. These motors drive the elevators by means of malleable iron chains.

One 3 horse-power motor attached to a portable elevator. This machine is used for elevating the grain from the floor and for weighing it into sacks. The motor drives by spur gearing, a raw hide pinion being placed on the axle. This motor, and the three mentioned above, are supplied with current by means of flexible conductors from the plugs in the central sheds. They are switched on direct without any starting resistance, and have their rotar circuits permanently short circuited.

Figs. 4, 5, and 6, show various applications of the motors.

Mr. Weekes, in reporting on this installation for the General Electric Company, says:—

I was most particularly interested in the combination of light and power from the same system of mains. Carefully

watching the lights when the motors were switched on, no appreciable flicker could be seen, except in the case of the 36 horse-power motor.

In this case the effect was due to the motor being considerably overloaded, and I understand that the directors of the Liverpool Grain Storage Company have ordered a 60 horse-power motor to take its place.

In conclusion I will summarise the advantages of a three-phase plant, as above, for general factory purposes.

1. There are no collectors or brushes used on the motors when working. This item of cost is entirely done away with in the three-phase system.

2. The three-phase motors, as supplied to the above company, are practically self-regulating as regards speed. The maximum variation between no load and full load is about 3 per cent.

3. The motors have a good starting torque when switched direct on to the supply mains.

4. Practically no skilled attention is required for these motors. The bearings are all provided with ring automatic lubrication, and as they are switched direct on without starting gear, anyone is capable of working them.

5. The motors are considerably lighter than machines of the same output of the direct current type.

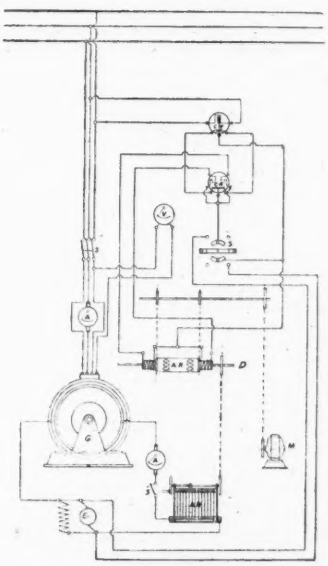


Fig. 2.

6. The motors can be placed in positions where, owing to dust and dirt, a direct current motor, unless most carefully boxed in, could not be employed. The quantity of dust settling on the three-phase motors there would soon cause trouble with a direct current plant. The present plant, however, has shown no defects arising from this cause.

7. The same remarks apply as to the advantage of the three-phase type of motors for damp positions. The coils on the stator, which are subjected to the full voltage of the supply, can be easily waterproofed. The conductors on the rotor can also be simply protected, and if required can be so designed that there is never more than a few volts difference of potential between them and the iron core in which they are embedded.

As a general conclusion, the above examples of the application of the three-phase system shows that the somewhat generally accepted idea that the advantage of this method of transmitting power is only advantageous when long distances have to be negotiated is erroneous, and the Liverpool Grain Storage Company are so well satisfied with the working of the plant installed on their premises that they have been supplied with another 36 H.P. and a 3 H.P. motor, and have decided to extend the plant to their elevators and conveyors on the Eastern Block, and will thus double the horse-power installed.

The system is thus equally applicable to the distribution of power and its subdivision into small units over a factory, and the motors and details of the system can be worked by the unskilled workman.

It is also a matter of interest that this, the first three-phase installation in this country which has proved a complete success has been designed and carried out on behalf of the General Electric Company, Limited, by their chief engineer, Mr. T. Hawkins, who, before being appointed to the management of this new departure of the General Electric Company, has made a prolonged tour on the Continent, carefully studying the various systems for transmission of power and distribution schemes in use there.

His report has caused an agreement to be made with the Maschinenfabrik Oerlikon, whom he considered leading in this direction, according to which the General Electric Company will be enabled to manufacture polyphase plants of all sizes in their Manchester Works, in accordance with designs and patterns that have stood the test of many years' practical work in factories, mines, &c., in almost every country in the world.

Though only commencing in this direction recently, the General Electric Company have been successful in obtaining orders, so far, for installations exceeding an aggregate of 2,000 horse-power, of mostly three-phase machinery, and as they have the sole rights for the Oerlikon patents for all the British Colonies, it is highly satisfactory to know that many of the colonial orders that have hitherto been necessarily given on the Continent, will now be manufactured in this country.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 116.)

Kidderminster-Stourport. — A Kidderminster paper says that the contract of Mr. Geo. Law, of Comberton Hill, had been accepted for carrying out certain work connected with this electric line for £24,000, with the exception of supplying the boilers, engines, cars, dynamos, and the poles for the electric wires. Mr. Law has already entered upon the work, and hopes to have his part of the work completed by the commencement of next year. It is intended to complete the Kidderminster section first. The generating station will be erected at the back of the Castle Spinning Mill, on the edge of the canal. The foundations have been excavated, and the brickwork has already been carried to the level of the surface. The car shed will measure 76 feet by 56 feet, the boiler house 40 feet by 38 feet, and the engine house 38 feet by 36 feet. Mr. Law is working under the supervision of the consulting engineers, Messrs. A. Dickinson & Co., of Birmingham. He hopes to have the generating station and out buildings completed in about two months, and then the company will at once proceed to put in the machinery.

Leeds.—One of the cars to be used in connection with the Roundhay-Kirkstall electric tramways was last week run along a section of the route, from the car station in Kirkstall Road to the Abbey. The object of this proceeding was to ascertain whether proper contact was obtained between the trolley bar on the car top and the overhead wire. The trial was satisfactory.

North Shields and Tynemouth.—The British Electric Traction Company has acquired a controlling interest in the North Shields and Tynemouth District Tramways, Limited.

Sunderland.—The Tramways Company has made an offer to the Tramways Committee to sell the whole of its lines and rolling stock to the Corporation, and to adopt electric traction, if the Corporation will lease the undertaking to the company for 21 years. The Committee, when the offer was considered, passed a resolution in favour of electric traction, and instructed Mr. J. F. C. Snell, the Borough Electrical Engineer, to prepare estimates and go into the entire question, and report to an early meeting of the Committee.

St. Helen's.—For the purpose of securing information which will be of use to the Corporation when they consider the proposed introduction of the electric traction on the St. Helen's Tramways, a deputation of the Council are, with representatives of the Tramway Company, visiting a number of places where electric traction has been adopted. The deputation have visited Leeds, West Hartlepool, and Birmingham, and on Saturday they visited Coventry and several other towns in the Midlands.

Tampering with Trolley Fittings.—A labourer travelling on one of the Dublin electric tramways caught hold of a rope attached to the trolley wheel, and caused about £4 worth of damage. The wheel flew upwards, and caught in the cross-wire, causing damage to the trolley-pole and breaking off the wheel. The car was stopped, and another motor-car had to take it back to Blackrock. The accused was charged before the Kingstown chief magistrate last week, and was remanded on bail.

The L.C.C. and Tramways.—The London County Council on Tuesday approved of the Highways Committee's recommendation that powers be applied for for the construction of a tramway over Westminster Bridge along the Embankment to Blackfriars. The best thing the Council can now do is to adopt electric traction. It is a splendid opportunity.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec, 19th, 1895 ...	July 20th, 1987.
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Zanzibar-Mombassa	July 13th, 1897 ...	...
Accra-Kotonon	July 15th, 1897 ...	...
Capetown-Mossamedes ...	July 19th, 1897 ...	...
Cayenne-Pinheiro	July 22nd, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be sent in plain language.

April 21st, 1897.—The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

Norwich and the Telephone.—A deputation of Norwich traders waited upon the Duke of Norfolk, Postmaster-General, on 19th inst., for the purpose of stating their case on the question of cheapening and extending the telephone service of that city. The deputation was introduced by Sir Harry Bullard, M.P.

The Telephone Service.—A circular is being issued, signed by Mr. Robert Mellors, Secretary of the Association of Trade Protection Societies of the United Kingdom, and dated Nottingham, July 15th, containing a statement with regard to the telephone service, together with a letter received by Mr. Mellors from the Postmaster-General in reply to a letter forwarding a copy of a resolution adopted at the 49th annual meeting of the association. The resolution pointed out, says the *Times*, that the difficulties connected with telephonic communication were a serious impediment to business, and the hope was expressed that the Postmaster-General would speedily provide increased telephonic lines, while a desire was also expressed for the hire of telephonic instruments at less cost than that now charged. In the course of the statement given in the circular, the high annual rents charged in this country for telephonic instruments are contrasted with the rates prevailing on the Continent. It is considered reasonable, owing to various circumstances, that a higher price should prevail in England than in some other countries; but it is submitted that the present rent charge is excessive, and that the service would pay quite as well at reduced rates, by the probable increase in the number of subscribers. Thus, Stockholm, with a rent of £2 16s. for Government telephones and £4 9s. for privately-owned telephones, and a population of 200,000, has 20,000 telephones; Nottingham, with telephone rents very much higher, and with a population of 240,000, has 1,350 instruments. It is further pointed out that the system of charging by distance has been abolished in letter carriage and with telegrams, but has been adopted with the telephonic service for reasons not obvious. What is wanted is a larger extension of the telephonic service, at uniform rates and cheaper rents. The Postmaster-General's reply, dated July 10th, to the association is to the effect that a very large number of additional trunk lines have either been recently completed or are in course of construction, and that, so far as his Grace is aware, the service is now satisfactory, except in a few cases where difficulties have prevented the erection of additional trunk lines with such speed as he could have wished. If, however, any particular case is specified by the association in which the trunk wire accommodation appears to be inadequate, the Postmaster-General will be glad to consider the matter. As regards the question of charges for the hire of telephonic instruments, his Grace "is giving careful consideration to the whole question, and he will be glad if he should find it possible to meet the wishes expressed in the resolution."

Telegraph Rates.—The *London Gazette* of Tuesday last contains a complete list of the rates chargeable for foreign telegrams from July 1st, 1897.

Telegraph Codes.—Some time ago it was announced that all legitimate words in existing codes would be inserted in the new edition of the Official Vocabulary for Code Telegrams now in course of preparation, if such codes, or a list of the words comprised in such codes, were forwarded to the International Telegraph Bureau at Berne before March 31st last. Subsequently the date for the reception of such codes or collections of code words was extended to June 30th last. The director of the Bureau has now consented to further extend the date to September 30th next.

Telephonic "Disturbances."—We cull the following interesting paragraph from last week's *Commerce*:—We offer our congratulations to Mr. Franz Baum, photographer, of Manchester. He has pluckily tackled the National Telephone Company, and come off victor. He became a subscriber to the so-called telephone service at the beginning of 1895, and innocently entered into an agreement binding him to subscribe for three years. He paid his first £10 and repented at leisure. The telephone was no use to him—nay, it was an instrument of torture. He complained and expostulated. The complaints and expostulations had the usual result, and Mr. Baum took the heroic course of refusing to carry out his agreement and requesting the removal of the telephone. The company sued for £20 under the agreement. We are exceedingly pleased that they have not been successful. The plaintiffs had to admit that the defendant had, no doubt, some cause for complaint, "especially about September, 1896, when there was some disturbance of the whole system, owing to the change from overhead to underground wires." This was, no doubt, a most excellent excuse, but we know of any amount of "disturbances" without any such change going on. However, the end of it was that instead of the company getting £20 more, their subscriber got the £10 back he had already paid. Whereat we are joyful, and hope Mr. Baum's excellent example will be followed.

CONTRACTS OPEN AND CLOSED.

OPEN.

Birkenhead.—July 23rd. The Corporation wants tenders for the supply and laying complete of cables, street boxes, &c. Consulting engineer, Mr. J. N. Shoolbred, 47, Victoria Street, S.W.

Carlisle.—August 12th. The Corporation want tenders for boilers, mechanical stokers, dynamos, storage battery, switchboard, boosters, arc lamps, feeders, mains, &c., for the electric lighting undertaking. See our "Official Notices" for further particulars.

Cork.—July 23rd. Tenders are invited by the Organising Committee of "Jericho" for the lighting of the bazaar by electricity, in accordance with specification to be seen at the "Jericho" office. Tenders to Mr. St. John Barry, secretary, Cork.

Derby.—July 26th. The Corporation want tenders for the supply and laying of high tension cables, junction boxes, cable and hauling winch, transformer boxes, switches, safety fuses, &c. Electrical Engineer, Mr. J. E. Stewart.

France.—The French Post and Telegraph Authorities in Paris are inviting tenders, until the 27th inst., for the supply of a switchboard for the Wagram telephone office in that city. They are also inviting tenders until August 3rd for the supply of a quantity of electro-magnetic apparatus. Tenders to be sent to the Sous-Secretariat d'Etat des Postes et de Telegraphes, Rue de Grenelle, 103, Paris.

Halifax.—July 26th.—The Corporation want tenders for the supply of trolley wire, bonds, and insulators for the new electric tramways. Electrical engineer, Mr. T. P. Wilmshurst.

Hammersmith.—July 21st. The Vestry want tenders for the supply of stores required for the electricity department during the period ending March 15th, 1898. Particulars from Mr. G. G. Bell, electrical engineer, 57, Fulham Palace Road, Hammersmith.

Hapton (Lancs.).—August 2nd. Tenders are invited for lighting the township with electricity from September 1st to April 30th. Particulars from Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, St. Anne's Terrace, Padiham.

Hull.—July 29th. The Electric Lighting Committee want tenders for the supply, erection and hiring of certain plant and machinery required in connection with the electric lighting installation during the winter of 1897-8. Borough Electrical Engineer, Mr. A. S. Barnard.

Newport.—July 30th. The Electric Lighting Committee invite tenders for the supply and erection of boilers, mechanical stokers, and other apparatus for the boiler house plant, steam alternators and exciters, accumulators, steam and exhaust pipes, switch gear, arc lamps, posts, &c., coal elevator and "allowance for day-load plant." Consulting Engineer, Mr. Robert Hammond.

Port Elizabeth.—September 21st. The Town Council invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town to private houses, stores, &c., for terms of 5, 15, 20, 25 or 30 years respectively. See our "Official Notices" for further particulars.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Sedgfield.—August 7th. The Durham County Asylum Visiting Committee want schemes and specifications for the electric lighting of Winterton Building at Sedgfield Asylum, 500 to 560 16-C.P. being required for that structure and a greater number for the main building. Particulars from Mr. Crozier, County Engineer, Shire Hall, Durham.

Sofia.—September 22nd. The Secretary of State for Foreign Affairs has received a despatch from the Acting British Consul-General at Sofia, stating that the municipality of that town invite tenders for—(1) The supply of electric current to light the streets as well as public and private buildings in the town and the supply of electric power; and (2) The construction and working of electric tramways in the town and suburbs. Tenders will be received at the offices of the municipality of Sofia. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Spain.—Tenders are at present being invited by the Municipal Authorities of Guadix (province of Granada) for the electric lighting of the public streets of the town. Tenders to the Secretario del Ayuntamiento de Guadix (Granada).

Spain.—August 5th. Tenders are being invited by the General Direction of the Spanish Posts and Telegraphs for the supply of 14 tons of copper sulphate for the telegraph service. Tenders to the Direccion General de Correos y Telegrafos, Madrid.

Sunderland.—July 28th. The Corporation want tenders for combined arc lamp and trolley poles, and arc lamps and accessories. Electrical engineer, Mr. J. F. C. Snell.

CLOSED.

Halifax.—The following orders have been given out in connection with the electric tramways:—

Leeds Steel Works, Limited; 630 tons of steel rails at £6 10s. per ton, and 30 tons of fish plates at £8 10s. per ton
Mr. E. Heaton; Lancashire boiler for the electricity works at £415.
Mr. J. Proctor; supplying and fixing a mechanical stoker and making alterations to existing mechanical stokers at the electricity works for £101.
Askham Bros. & Wilson, Limited; 29 sets of Marshall's patent automatic points at £19 per set, and two sets of points (special curved) at £15 12s. 6d. per set.
Messrs. Spencer; 100 poles for conveying overhead wires, £1,090.

London.—The tenders sent in for the electric light installation at Grove Hospital for the Metropolitan Asylums Board were considered by the Board on Saturday. The following is a list given in *Daily Tenders and Contracts*:—

	Sec. A.	Sec. B.
Mavor & Coulson	£4,011	£4,950
Crompton & Co.	4,420	5,400
Joel & Potter	—	—
T. Scott Anderson	4,450	5,700
Brush Electrical Engineering Co.	4,872	5,440
Electrical & General Engineering Co.	—	—
W. J. Fryer & Co.	4,497	6,647
Laing, Wharton & Down	5,099	6,059
J. H. Pickup & Co.	4,790	6,890
Sharp & Piper	5,790	6,450
Fowler, Lancaster & Co.	4,985	7,448
F. B. Camden & Co.	—	—
(2.) *For One Section Only.*		
Siemens Bros. & Co.	4,180	—
J. H. Holmes & Co.	4,120 to 4,890	—
V. G. Middleton	—	7,412
A. H. Wood	—	4,720

The tender of Messrs. Siemens Bros. & Co. for the supply and fixing, at £4,180, of the machinery, pipe work, and accumulators comprised in Section A was accepted, also that of Messrs. Mavor & Coulson at £4,950 for wiring and fitting up the hospital (with an allowance for the electric bell and telephone work) in Section B.

Southampton.—At the last meeting of the Town Council the Electric Lighting Committee reported that the three tenders received for supplying and erecting boilers, mechanical stokers, &c., at the new electric lighting station having been submitted to Mr. Manville, the consulting engineer, that gentleman recommended the acceptance of Messrs. Babcock & Wilcox's tender of £7,748 (less £290 to be allowed for alterations in the contract) in lieu of the tender of Messrs. G. C. Mallett & Co., London, at £7,353 15s., and stated a variety of reasons for the recommendation. The Committee recommended the Council to act on the engineer's report.—Agreed to.

Walsall.—The tender of Messrs. T. Parker, Limited, for supplying and erecting a transformer at the electricity works at £558, also that of Messrs. Callenders Cable Co. for supplying and laying a new feeder cable in connection with the extensions, have been accepted by the Council.

NOTES.

Exhaust Steam Heating.—Exhaust steam from electric light stations is to be used for heating in several parts of the United States. A contemporary says that the Edison Electric Illuminating Company of Topeka, Kan., has given out an order for nearly a mile of underground street mains for the purpose of utilising their exhaust steam for the heating of buildings, and it is estimated that the company will have an income the first year from heating of about $6,500, derived mostly from the sale of exhaust steam. The Taylorville, Ill., Electric Company is also putting down similar plant for the purpose of heating the principal buildings there.

Fatality.—A lady cyclist was thrown off her machine in front of one of the Dublin-Dalkey electric tramcars last week, and was run over. Death was instantaneous.

The Motor Car Industry in France.—The *Engineer* has determined to show that no motor car industry exists anywhere, and has now metaphorically carried the war into the enemy's camp. Curiously enough, just as this fulmination appears in the columns of the *Engineer*, the works of the Roger Company, against whom many of the remarks are levelled, is reported as being destroyed. There must surely be some kind of industry in France, or whence came all the vehicles of the *Petit Journal* and other contests? and the *Engineer* admits forty makers of self-propelled vehicles; but most of these are carriage builders, who put other makes of motors into their vehicles, or have motors presented them for use by sanguine inventors. Except the Daimler, the only other motor which has been much used is the Benz. What, asks the *Engineer*, is the Anglo-French Motor Carriage Company doing with the Roger business? True, the shop in Paris has been destroyed; but there were to have been larger French shops, and a large English works also at Birmingham was contemplated. A large demand exists, we are told, in Paris for motor vehicles; but the French seem to have failed to grasp the position at the time of the boom, and have made little or no advance since.

Electrolysis by Alternating Currents.—The present number of *L'Eclairage Electrique* contains the concluding remarks of Dr. Riccardo Malagoli as to his experimental investigation of the potential curve at the terminals of a voltameter traversed by an alternating current. The voltameter, in series with a non-inductive resistance, is connected to the terminals of a small alternator. By means of a separate commutator, rotating with the axle of the dynamo-armature, a second circuit can be closed at any particular phase. This second circuit contains a galvanometer, and can be connected either to the terminals of the voltameter, or to those of the non-inductive resistance. Curves are then drawn to represent the potential law for a complete cycle in each of the two cases. It is found that there is a real difference of phase between current and potential difference at the terminals of the voltameter, which agrees with the results of Mengarini.

Ampere-turns.—A method for determining the number of turns on a field-magnet, which does not necessitate unwinding the coils, is described by M. Camichel in *L'Eclairage Electrique*. The case is given of a dynamo having two poles, A and B. The two coils on A and B are first disconnected from one another. If a current is sent through coil A from a battery of accumulators, coil B is traversed by a certain magnetic flux; this may be increased by closing the air-gaps with sheet iron. A separate coil, B′, of fine wire is now wound over B, and connected to the ends of B. A ballistic galvanometer is joined across the common terminals thus formed. It is clear that if B and B′ are oppositely wound, a value can be found for the number of turns on B′, such that on closing the battery circuit round A, no deflection is produced at the galvanometer. In this case, the number of turns of B′ is the same as the required number round B.

India-Rubber Fiasco. — It is said in the newspaper press that the prospectus of the British India-Rubber and Exploration Company, to which we referred in our May 28th issue, was issued without the authority of the directors. While the prospectus was before the public, the Colonial Office pointed out an incorrect statement contained therein regarding the register of titles to land on the Gold Coast. A winding-up order has now been obtained. Of the quarter of a million capital, only £3,000 was applied for.

Appointment.—Lieut.-General Victor von Podbielski has been appointed to succeed the late Dr. von Stephan as head of the German Post Office. Lieut.-Gen. von Podbielski was born at Frankfort-on-the-Oder in 1844, and is the only son of General von Podbielski, who wrote an excellent account of the siege of Paris. The new Postmaster General entered an Uhlan Regiment in 1862, and served on the staff of General Caprivi during the Franco-German campaign in the 10th army corps.

Appointment Vacant.—The Birmingham Markets and Fairs Committee want a thoroughly competent man to take charge of the electric lighting installation at the new Meat Market. See our "Official Notices."

Terrestrial Magnetism.—*Science Progress* for the current month gives a table of magnetic elements as determined at the observatories, whose publications are received at Kew. It includes measurements of declination and inclination, from which are derived the horizontal and vertical forces, in C.G.S. units.

Electrical Engineering Classes.—From our "Official Notices" particulars can be obtained of the "Electrical Measurement and Practical Electricity" Classes, which will be begun in October next by Prof. Andrew Gray at the University College of North Wales, Bangor.

Owen's College, Manchester.—Our "Official Notices" contain a notification to the effect that the new session of electrical instruction commences on October 5th.

Accident.—Last Saturday morning an accident occurred at the Ayr Electric Light Sub-Station in Hope Street. While Alexander Cameron was working in the station his right shoulder came in contact with the high tension cable, with the result that he was rendered unconscious and severely bruised.

Gold Extraction.—Mr. E. L. Oppermann sailed per *Oratava* to superintend the erection of the gold extracting plant at the Lake View Mines, West Australia, and at the Gloucester Gold Mines, New Zealand. These plants have been constructed by Mr. Carl Oppermann on behalf of the Oppermann-Fischer Patents Proprietary Company, Limited, who are the owners of this new system of gold recovery.

Wireless Telegraphy.—The *Daily Chronicle* learns from Spezzia that Signor Marconi's wireless telegraphy during the recent trials worked on land at a distance of 19 kilometres, and on sea at a distance of four kilometres between two war ships perfectly equipped and moving in contrary directions.

Presentation.—The directors of the City of Bath Electric Lighting and Engineering Company, whose undertaking was, as our readers will remember, purchased by the Town Council quite recently, evidently hold a very high opinion of Mr. G. F. Metzger, A.M.I.C.E., and of his services rendered as engineer-in-chief of the company. A complimentary luncheon in honour of Mr. Metzger was held at the Royal Hotel, Bath, on Monday, and Mr. T. O. Callender, the chairman, presented Mr. Metzger with a valuable keyless gold watch and chain, the watch being suitably inscribed. We take this opportunity of expressing the hope that Mr. Metzger's relations with the municipality as City Electrical Engineer will be as cordial as with the company.

Cricket. Wandsworth v. St. Luke's.—On Saturday last the staffs of the various contractors engaged on these works played a friendly game at Balham, resulting in favour of St. Luke's. Afterwards the teams and their friends, to the number of 35, adjourned to the Alma Hotel, Wandsworth, where host Parrott provided a substantial dinner. In the unavoidable absence of Mr. A. J. Lawson, manager of the County of London Company, the chair was taken by Mr. B. Deakin, resident engineer, Wandsworth, supported by Messrs. Dale, Donnet, Pringle and Goslin. After the dinner the usual toasts were given, and the evening was concluded by an enjoyable smoking concert.

Detroit Telephone Convention.—Our American contemporaries report in detail the proceedings of the Telephone Convention at Detroit, an assembly of delegates from companies independent of the American Bell Telephone Company. It was sought to attain a basis of common action and mutual support.

NEW COMPANIES REGISTERED.

Compressed Air Traction Company, Limited (53,212). Registered July 6th with capital £125,000, in £10 shares (2,500 preference) to adopt an agreement with the American Air Power Company, and to acquire, develop, work, and deal with any patented inventions and rights connected with mechanical traction, and the production, treatment, storage and use of compressed air and electricity. The subscribers (with one share each) are: N. S. Russell, C.E., 39, Coleman Street, E.C.; F. S. Isaac, 22, Great Winchester Street, E.C., merchant; J. Morris, 17, Throgmorton Avenue, E.C., solicitor; J. H. Puleston, 2, Bank Buildings, E.C., merchant; J. H. Duncan, 39, Coleman Street, E.C., C.A.; E. E. Jessel, 39, Coleman Street, E.C., secretary; T. Bett, 118, Bishopsgate Street Within, E.C., merchant. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

Penny-in-the-Slot Electric Supply Syndicate, Limited (53,329).—Registered July 15th, with capital of £10,000 in £1 shares to adopt an agreement with the Electric Lighting Extension Syndicate, Limited, and to carry on the business of suppliers of electricity, electricians, electrical engineers, &c. The subscribers (with one share each) are: C. O. Bastian, 8a, Manchester Square, W., electrical engineer; F. Sidney, 98, Sewardstone Road, Victoria Park, N.E., clerk; E. Howard, 15, Abchurch Lane, E.C., gent; J. C. Herrington, 3, Spanish Road, Wandsworth, clerk; O. L. Richardson, 113, Roman Road, Barnsbury, clerk; T. R. Marshall, 39, Beck Road, Mare Street, N.E., stationer. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first. Qualification £100; remuneration £100 each per annum, and £150 for the chairman. Registered by W. T. Hick, 2, Church Court, Clement's Lane, E.C.

Cycle Trade Publishing Company, Limited (53,322).—Registered July 14th with capital £40,000, in £1 shares, to acquire the copyright of the *Cycle Trader, the Cycle and Trades Diary, and the India-Rubber and Gutta-Percha and Electrical Trades Journal*, and to acquire and carry on the business of the Cycle Trade Publishing Company, Limited (registered in 1896). Table "A" mainly applies. Registered office, 19 and 21, Wilson Street, E.C.

J. D. F. Andrews & Co., Limited (53,329).—Registered July 15th with capital of £10,000 in £1 shares (5,000 preference), to acquire and carry on the business of electrical engineers and manufacturers carried on as "J. D. F. Andrews & Co.," at Fulham, S.W., and to adopt an agreement with J. D. F. Andrews. The subscribers are:—F. A. Jones, Llandovery, South Wales, banker, 500 shares; G. B. Samuelson, 7, Cadogan Gardens, S.W., manufacturer, 10 shares; S. F. Dupree, 20, Burstock Road, Putney, contractor, one share; J. H. Hawksworth, 25, Redgrave Road, Putney, electrical engineer, one share; Mrs. M. T. King, 72, Waldemar Avenue, S.W., one share; Mrs. A. B. Andrews, 45, Fulham Park Gardens, S.W., one share; J. D. F. Andrews, 45, Fulham Park Gardens, S.W., electrical engineer, one share. The number of directors is not to be less than two nor more than seven; the first are J. D. F. Andrews, G. B. Samuelson, and F. A. J. Jones; qualification £10, no remuneration. Registered office, Fulham Electric Works, Putney Bridge Station, Fulham, S.W.

Smithfield Markets Electric Supply Company, Limited (53,354).—Registered July 18th, with capital of £100,000 in £1 shares to acquire and turn to account a concession for lighting Smithfield Market, in the City of London, with electricity, and to adopt an agreement with R. Jewell. The subscribers (with one share each) are:—A. H. S. Browne, Gleneagle Road, Streathan, S.W., clerk; T. Browne, 9, Oberstein Road, Clapham Junction, engineer; H. M. Manley, 16, Stafford Terrace, Kensington, gentleman; P. J. Hayes, Crieve House, Ealing, W., secretary; J. Smith, 42, Lennard Road, Penge, S.E., clerk; D. Robinson, 14, Jessica Road, Wandsworth Common, clerk; A. Manning, Beechfield, Watford, gentleman. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification, £250; remuneration £950 per annum divisible. Registered by Davidson & Morris, 40-42, Queen Victoria Street, E.C.

Sax, Slatter & Co., Limited (53,362).—Registered July 16th, with capital of £100,000 in £1 shares, to acquire a part of the business carried on by Julius Sax & Co., Limited, at Forester's Hall, Clerkenwell, E.C., and to adopt an agreement with A. Slatter, and to manufacture, sell, and deal in dynamos, motors, electric measuring instruments, batteries, telegraph and telephone instruments, bells, cables, lamps, &c. The subscribers (with one share each) are:—A. Slatter, 7, Ridgmount Street, Bedford Square, W., electrical engineer; B. Parry, 2, Sterndale Road, West Kensington, clerk; H. Stebbings, 34, Chryssell Road, Brixton, clerk; A. G. Morrish, 54, Gresham Street, chartered accountant; C. F. Glynn, 50, Richmond Terrace, Clapham Road, agent; S. Marler, 176, Sloane Street, W., auctioneer; G. H. Hoyle, Parliament Mansions, Westminster solicitor. The number of directors is not to be less than three, nor more than five; the first are S. Marler, A. Slatter, and J. Perkins. Qualification £500; remuneration as fixed by the company. Registered office, 54, Gresham Street, E.C.

National Electric Free Wiring Company, Limited (53,364).—Registered July 16th with capital £250,000, in £1 shares, to adopt an agreement with the Electric Free Wiring Syndicate, Limited, for the acquisition of its business, and to carry on the business of electrical engineers and contractors for the supply of electrical plant and appliances. The subscribers (with one share each) are: R. S. Bain, Elmbourne Road, Upper Tooting, C.A.; T. J. Bowles, 27, Upper Marylebone Street, W., gentleman; G. Ellis, J.P., Landguard, Granada Road, Southsea; J. T. Jervis, M.Inst.C.E., 28, Victoria Street, S.W.; F. J. Leslie, 15, Union Court, Liverpool, solicitor; H. Gibson, 8, Great St. Helen's, E.C., solicitor; J. Atherton, Huyton, Liverpool, electrical manufacturer. The number of directors is not to be less than four, nor more than nine. The subscribers are to appoint the first; qualification, £500; remuneration, £1,200 per annum, and a share in the profits divided. Registered by Deacon and Co., 9, Great St. Helen's, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Brazilian Submarine Telegraph Company, Limited (6,886).—This company's annual return was filed on June 1st, when the whole capital of £1,300,000 in £10 shares was taken up and paid for in full.

Woolwich District Electric Light Company, Limited (31,814).—This company's annual return was filed on April 10th, when 9,466 shares were taken up out of a capital of £10,000 in £1 shares. 884 are considered as paid and £1 per share has been called and paid on the other 8,582 shares.

Baily, Grundy & Barrett, Limited (38,004).—This company's annual return was filed on May 12th, when 662 shares were taken up out of a capital of £10,000 in £5 shares. £5 per share has been called, and £3,300 paid, leaving £10 in arrears.

West India and Panama Telegraph Company, Limited (11,116).—This company's annual return was filed on June 9th. The capital is £2,445,630 in 200,000 ordinary, 34,563 first preference, and 10,000 second preference shares, all of £10 each. 88,321 ordinary, 34,563 first preference, and 4,669 second preference have been taken up, and £10 per share called, resulting in the payment of £1,275,530.

Conduit and Insulation Company, Limited (50,527). This company's statutory return was filed on May 6th, when 27,832 shares were taken up out of a capital of £40,000 in £1 shares. 15,500 are considered as paid. £1 per share has been called on 7,100, 14s. per share on £5,150 10s. per share on 75, and nothing on 7, and £10,742 10s. has been paid.

F. H. Royce & Co., Limited (41,362).—This company's annual return was filed on June 3rd. The capital is £30,500 in £1 shares (500 deferred); 20,654 ordinary and 500 deferred have been taken up, and 12,514 are issued as paid; £8,640 has been called and paid on the rest.

Cuttriss, Wallis & Co., Limited (33,857)—This company's annual return was filed on July 3rd, when 651 shares were taken up out of a capital of £10,000 in £5 shares. 300 shares are considered as paid, and £1,755 has been called and paid on the rest.

Hastings and St. Leonard's-on-Sea Electric Light Company, Limited (16,505).—This company's annual return was filed on June 9th, when 2,722 shares were taken up out of a capital of £50,000 in £10 shares, and paid for in full.

CITY NOTES.

Direct United States Company.

THE accounts of this company for the six months ending June 30th ult. are, as usual, very clear, and easily understood. There are items in the reserve fund account which deserve special notice. The cable, it may be remembered, was laid in 1874, and it is interesting to note that the balance of the reserve fund is just large enough to pay for a duplicate line when the necessity for this arises. The cable, which was manufactured by Messrs. Siemens Brothers, has up to the present enjoyed a 23 years' life, and to judge from the annual cost of repairs, seems likely to live still longer. When we consider that the 1865 and 1866 cables of the Anglo-American Company were contracted for at a cost of nearly one million sterling each, and were abandoned after about 11 years life, the comparison of present prices and of excellence of manufacture is very striking. In addition to the balance of reserve above referred to, viz., £338,488 15s. 8d., the Direct United States Company has paid off a debenture loan of £73,367 14s. 7d., has also paid £23,638 10s. 5d.—the cost of diverting their cable from Torbay to Halifax—and, further, has expended in repairs from July 1st, 1877, to June 30th, 1897, including cable costing £49,570 12s. 1d., the sum of £162,756 5s. 11d.

This expenditure on repairs, including new cable, is also interesting, as it shows that an Atlantic cable can be kept in repair for 20 years at an annual charge of £8,138. A Pacific cable of about three times the length, and laid in more favourable water, should not, therefore, cost more than £24,000 per annum for repairs, including new cable.

Crompton & Co., Limited.

THE annual meeting of this company was held yesterday afternoon at Cannon Street Hotel, Mr. John Trotter presiding. The report and accounts, together with the circular which accompanied same, were printed in full in our last issue.

The CHAIRMAN, in moving the adoption of the report and accounts, made some remarks upon the work of the current year, as the extraordinary general meeting would deal with the general aspect of the company's affairs. The profit and loss account for the year ended March 31st, 1897, showed that a gross profit of £42,290 had been made, and he congratulated the shareholders upon the return to comparative prosperity of the annual working of the company. They suffered very greatly from the fire, and last year were unable to furnish a profit and loss account. He wished the net profit had been somewhat larger, but he was really surprised at the results, considering the difficulties under which they were still labouring at Chelmsford. The trading expenses amounted to the very large sum of £15,900, but when they got into the new works which are now practically completed—they were already beginning to move the machinery in, and it would not be a long period before the works were, practically, moved into the new quarters—they hoped to bring about economies in the present working because they were now working in a cramped condition under distinct disadvantages. The speaker went over the various items in the accounts. There was a balance of £4,180 net profit. In the general balance-sheet there was shown an increase of £21,245 in loans from bankers, bringing that item to £35,000 odd. It was satisfactory to see that creditors, although the business had been very largely increased, the actual increase of sales last year compared with the previous year, amounting to 40 per cent., were even lower. Freehold property had increased from £12,780 to £28,880, and this increase was due to the new works and payments made for what was required to complete the factory. The trade debtors item reflected increased business, the total being £67,935—an increase of £9,840; therefore, the amount owing to the company had increased £9,000 odd, and that owed by the company was £3,000. They were centering the two really important departments of the company—the contracting and manufacturing—at Chelmsford. They had endeavoured to get rid of such excrescences as they could, so as to prevent expense due to widely-spread management, and to enable the officials of the company to centre their attention upon the profit-earning portions of the business. That policy they had successfully carried out. They were just about to reap the benefits of the economies which the new works would bring about, and if they could under such disadvantageous circumstances show such satisfactory results and a moderate net profit, he thought they might reasonably expect that when the difficulties were removed they would be able to show a still more satisfactory result. He had no fear for the coming year as regards business. They had got satisfactory contracts already, and there was every reason to suppose not that they would be curtailed, but that they would be—bar accidents—larger than last year, and with still more satisfactory profits. Regarding the engineer's strike of 700 men, 140 had gone out, and they did not anticipate that this would develop into anything really serious; but it was impossible for him to foretell. He saw no clouds on the working horizon at the present moment but the strike. He saw, however, a good many clouds behind them.

Mr. CROMPTON seconded the adoption of the report.

A discussion followed, in the course of which Mr. THORNTON said they had heard for many years that the future of the company looked so well, but they never got any further than that. In regard to trade debtors, he thought a company that was in need of money should not allow £37,000 to be outstanding. Better to get the money in if they had to make a reduction. He thought the Chelmsford Company should be put down as a loss. It was put into assets but never would be anything. He would like to see the whole £30,000 goodwill wiped out. Let them make things as bad as they could and place themselves in a very good position.

Another SHAREHOLDER complained that the £4 per share on the 1,928 shares should have been called up before, instead of raising loans at the bankers.

Mr. TUFNELL assumed the directors had not put into force the £50,000 borrowing powers for which they applied to the shareholders in December?

THE CHAIRMAN, in answer to these and other questions, said that the freehold stood at a very large amount, because it covered both the old and the new freehold. They proposed to dispose of part of the old factory, and from inquiries and valuations made, he did not anticipate any difficulty in getting rid of such portion as they could spare at the same figure as it stood in the books, and then the freehold item would be considerably reduced. The board was persuaded that the trade debtors were a very large amount, and that matter would be dealt with at the extraordinary general meeting. The Chelmsford Lighting Company was paying its way, and was a very satisfactory asset in the books. It was within their ideas to establish it as a separate undertaking; and if they could do that it would enable them to reduce by a considerable sum the amount overdrawn at the bankers. Part of the £50,000 had been used in connection with the temporary advance from the bankers.

The motion was carried unanimously, and the retiring director and auditors were re-elected.

An extraordinary general meeting of the company was then held for the purpose of passing the resolution altering the articles of association in accordance with the notice published in the REVIEW last week.

The CHAIRMAN, proceeding to explain the board's scheme for which the alteration in the articles was required, said they all considered that it was necessary to write down some of the items appearing on the assets side of the balance-sheet. The board was pledged to bring forward a scheme for dealing with what they considered was necessary to put the house in order. The amounts they had to deal with included the suspense account, £11,051, which they must provide for; the premium on issue of debentures, £9,775. Then a serious loss had been made in Australia. In connection with this, they were legally advised to take action against certain parties on the spot who were concerned in the matter, and they had done so, but what the issue would be he could not say. Anyhow, they at the present moment stood to lose £20,000 over it. Under the headings of trade debtors, investments in shares in other companies, and subsidiary companies, there was £20,000 belonging to Australia,

and they might consider them bad. It was only during the past year that it had turned out to be so bad as that. There was another manufacturing company, subsidiary to Crompton's, which, as a going concern, was a valuable asset, but it had had an unfortunate career, and they were endeavouring to deal with it. It represented another £9,000. Trade debtors they should write off £14,946 odd, and shares £2,100. Patents should be written down from £13,403 to £11,000. The cooking department, which stood at £5,166, they proposed to write down £2,166. Goodwill was to be reduced from £30,000 to £15,000. These sums brought it up to the total mentioned in the circular—£78,396. They had to deal with that large sum before they could have any dividend. They did not say their scheme was absolute perfection; but he did say that taking all the interests in the concern into account, and endeavouring to do justice to everyone, the scheme was the best they could do. He then explained the manner in which the money for this purpose was to be got. The call on the unpaid shares would be £7,688, and the year's profit was £4,180. These sums would be used, and the shares would be written down as explained in the circular. These would produce £66,000. One approached any alteration of the relative rights of shares in a company of this sort with very great carefulness. It was a serious matter to suggest any dealing with preference shares at all; but there were occasions when it was right that the board should not shrink from dealing with what was a very disagreeable subject, if they believed it to be in the interests of all parties concerned. The £140,000 preference shares took 7 per cent. of the profits, and those dividends were cumulative. There were cumulations on those shares now to the amount of £36,400. That had to be taken into account, as well as the loss of £78,000. Suppose that were all wiped off, and the company was making good profits, then the preference shareholders took 7 per cent., which would require £9,863; but if the profits earned amounted to £20,000—and in view of the growth of the business £20,000 was not out of the question—the preference shareholders would take that £9,863, but the ordinary shareholders would take the other £9,863 or 45 per cent. Those ordinary shareholders were very much in the nature of founder's shares. That ought to be taken into account in writing down. It was a state of affairs that required amicable arrangements with those concerned. There was £140,900 worth of preference shares issued at the present time, and they suggested that those shares in common with the ordinary, should be written down from £5 to £3, and that the cumulations should be wiped out. That, at first, sounded a very wrong thing to do. But where were those cumulations to come from, if they were paid to them solely out of the future profits of the company? Under the new arrangement, they would have all the future profits less one-eighth, the proportion of the ordinary shareholders, whom it was proposed to admit into the same body as the preference. They would put the company into a position of being an annual dividend-paying concern if they made profits, instead of leaving it with a dead weight round its neck in the form of the cumulative dividends, at which it would have to keep hacking year after year to pay off. They would get seven-eighths instead of one-half.

The chairman went further into the board's proposals at great length, and after a brief discussion in which the fairness of the proposals was impugned by several speakers, the alteration in the articles of association was approved, there being only two dissentients. Another meeting will have to be held to confirm the decision. A vote of thanks closed the meeting.

Electric Construction Company, Limited.

The fourth annual general meeting of this company was held yesterday at Winchester House, Old Broad Street, Mr. J. W. Barclay presiding.

The Chairman, in proposing the adoption of the report, said he took that position in consequence of the absence of Sir D. Cooper, the chairman of the company, through illness. Sir Daniel had prepared his speech, which he (Mr. Barclay) would read to the shareholders. In this the chairman said that the accounts showed a net profit for the eleven months ended May 31st of £17,399:—The directors recommended that £14,197 7s. be distributed as dividends; on the preference shares at the rate of 7 per cent. per annum, and on the ordinary shares 5½ per cent. (equal to 6 per cent. per annum) free of income-tax; the whole of the preference dividend to be paid on July 1st, and according to the practice established last year, one-half of the ordinary share dividend to be paid on July 31st, and the other half on January 31st next. After payment of these dividends a balance of £16,499 0s. 9d. would remain to be carried forward. Those results would, he believed, be satisfactory, especially when it was considered that the plant and buildings had been fully maintained, as well as £5,000 set aside to depreciation account out of the revenue of the 11 months. The amount at the credit of the depreciation account was now £18,000. The accounts showed general progress in the development of the business; they had been producing more, and had been able to do so at less cost, hence the increase in the profits. As stated in the report, their customers, the men employed, the output of manufactured goods and gross profits, all showed important increases, and there were at present in the workshops as many orders as they cared to have, and at prices which ought to yield at least their usual profits. Since the report was issued they had secured the contract for the electrical equipment of the Halifax tramways, and were thus obtaining our share of electric traction work. The expenditure was much the same as last year. They had tried to make reductions; but if they were to maintain the efficiency and reputation of their establishment, they can make little progress in that direction. They looked for improved results to an increased output, and they would be pleased to hear that in that object they had the full co-operation of their staff and employés. With regard to the further issue of capital and the reduction of interest on the debentures referred to in the report, the board had resolved to offer to the shareholders 8,657 preference shares at 15s. premium. He had only further to add the expression of his own great satisfaction with the steady growth and development of the business, and to acknowledge their high appreciation of the skill and willing services of the staff and employés of all grades, their relations with whom, he was glad to believe, were those of increasing confidence and mutual goodwill.

Sir Henry C. Mance seconded the adoption of the report, which was carried.

Eastern Telegraph Company, Limited.

The report of the directors for the half-year ended 31st March last, presented to the general meeting held at Winchester House yesterday afternoon, states that the revenue for the period amounted to £479,822, from which are deducted £110,109 for the ordinary expenses and £27,544 for expenditure relating to repairs and renewals of cables, &c. After providing £3,541 for depreciation of spare cable and £6,254 for income tax, there remains a balance of £332,373, to which is added £41,967 brought forward, making a total available balance of £374,340. From this has been paid interest on debentures and debenture stock, £30,113; dividend on preference shares, £20,296; and an interim dividend of 2s. 6d. per share on the ordinary shares, £50,000, leaving a balance of £273,931, out of which the directors have placed a balance of £20,000 to the reserve fund for maintenance ships, £10,000 to the fire insurance fund, £10,000 to the land and buildings depreciation fund, and £120,000 to the general reserve fund. The directors now recommend the declaration of a final dividend for the year of 2s. 6d. per share, and a bonus of 3s. per share, amounting together to £110,000, both payable on the 22nd instant, free of income tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares. The balance of £3,931 is carried forward. The revenue includes £34,024, dividends for the half-year upon the company's investments in other telegraph companies.

The 50th half-yearly meeting of the shareholders of the above company was held yesterday at Winchester House, Old Broad Street, the Marquis of Tweeddale presiding. The chairman, in moving the adoption of the report, after referring with regret to the death of Mr. Charles W. Earle, who had been a director of the company for some time, said that the board had appointed Mr. Clement S. Colvin to the vacancy. The gross revenue for the half-year under review amounted to £479,822, being an increase of £13,729. The traffic with India, and also with South Africa, had shown some tendency to decrease; but, on the other hand, the receipts from other classes of traffic had been fairly well maintained, and in some instances had been somewhat improved. During the late war with Greece and Turkey a temporary increase in the traffic with Greece occurred; but the traffic had now fallen below its normal proportions. However, now that peace had been assured, he thought there was every reason to hope they might have a recovery in that traffic. The total working expenses for the half-year had amounted to £110,109 as against £99,151, or an increase of £10,958. That item included £1,500 of a special character—£1,000 as a contribution to the Pender Memorial Fund, and £500 to the Indian Famine Fund. The Pender Fund had been closed, and the amount realised was about £7,600, £5,000 of which had been handed over to the University College of London to support a Pender laboratory there. The other increase was due to an increase in the salaries and the number of their staff at home and abroad. Considerable reductions had lately been made in several of their rates. He had a list of 45 reductions in the rates to and from Great Britain, Europe, Asia, Africa and Australasia, varying from 1s. 2d. to 4s. 4d. per word, and in addition to that other reductions had been made in local rates. It had always been the policy of the board not only to maintain the company's system in a perfect state of efficiency, but also to provide ample means of maintaining any increase of traffic arising from any cause whatever. Out of the profits of the half-year the directors had placed £20,000 to the reserve fund for maintenance of ships, £10,000 to the fire insurance fund, £10,000 to the land and buildings depreciation fund, and £12,000 to the general reserve fund. One shareholder had written saying he thought that too much was being put to reserve; but the fact was that in the past their reserves had been totally insufficient for possible contingencies.

Mr. J. Denison Pender seconded the motion, and the report was adopted.

The National Telephone Company, Limited.

The directors' report for the half-year ending June 30th, 1897, states that the income accrued in respect of the business of the half-year amounts to £476,883 0s. 7d., as compared with £430,767 15s. 8d. for the corresponding period of 1896, being an increase of £46,115 4s. 11d.* The working expenses for the half-year amount to £266,716 6s. 9d., as compared with £224,693 19s. 4d. for the corresponding period of 1896, being an increase of £42,022 7s. 5d. The net result for the half-year (after deducting the Post Office royalties, amounting to £43,156 1s. 5d.) is a profit balance of £167,010 12s. 5d., as compared with £166,523 18s. 4d. for the corresponding period of 1896, being an increase of £486 14s. 1d.* The rentals carried forward

* In connection with these figures, it must be borne in mind that the accounts for June, 1896, included the trunk line revenue for the first three months of that year, amounting to about £20,000, which revenue is now received by the Post Office.

for unexpired terms of running contracts amount to £499,962 17s. 8d., as compared with £438,321 15s. at the corresponding period of 1896 or an increase of £61,641 2s. 8d. Out of the available balance of £137,259 9s. 2d. shown by the net revenue account (No. 3), the board will recommend a payment of dividend at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares, 5 per cent. per annum, less income tax, on the third preference shares, and 6 per cent. per annum, free of income tax, on the ordinary shares. The board also propose to transfer £35,000 to the reserve fund, and to carry forward the balance of £5,665 13s. 2d. The sum of £193,562 3s. 7d. has been expended on capital account during the half-year, the bulk of it in the erection of 6,148 additional exchange and private lines required to meet the wants of new customers. The remainder of this expenditure has been incurred chiefly in the execution of underground work in substitution of, or supplemental to, the overhead system and with the object of offering greater efficiency of service.

In order to strengthen the financial position of the company and to provide for present and prospective needs, the board have recently issued the balance of the five per cent. third preference shares, to the nominal amount of £653,830. The average price realised was £5 16s. 6d. per share, resulting in a premium of £107,882 6s. 5d. This affords an opportunity for dealing with the premium account which stands in the last balance-sheet at £37,911 12s. 6d., and the board have decided to apply the amount now available in extinguishing the payment of £121,295 9s. involved in the redemption of the 4½ per cent. debenture stock in 1894. There will be a balance of £25,067 3s. 3d. still remaining to the credit of this fund.

The relations with the Post Office continue to be of the most satisfactory kind, and the harmonious working of the two establishments has resulted in the overcoming of many of the serious initial difficulties consequent upon the dual system involved in the transfer of the Trunk Service to the State.

At the general meeting four directors retire, and, being eligible, offer themselves for re-election, viz.: Mr. George Franklin, Sir W. Cuthbert Quilter, Bart., M.P., Mr. William Alexander Smith, and Mr. Joseph Thompson.

The Auditors, Messrs. Welton, Jones, & Co., also retire, and are eligible for re-election.

The Globe Telegraph and Trust Company, Limited.

The directors' report, to be submitted to the meeting on Tuesday, July 27th, reads:—"The balance-sheet and accounts for the year ended July 18th, 1897, with statement of the stocks and shares held by the company at that date, are herewith submitted. The net revenue of the company for the year, after deduction of expenses, amounts to £186,582 8s. 1d., and makes, with the balance of £948 8s. 8d. brought forward, a total of £187,530 16s. 9d. From this amount there has been distributed the sum of £127,866 12s. 11d. in interim dividends, leaving an available balance of £59,664 3s. 10d. The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 3s. 6d. per share on the ordinary shares, making, with previous distributions, a total dividend for the year of 6 per cent., less income-tax, upon the preference, and 4½ per cent. net (against 4½ per cent. for the preceding year) upon the ordinary shares, leaving a balance of £2,022 19s. 4d. to be carried forward to the next account. During the current year the West Coast of America Telegraph Company has been re-constructed, the £10 shares of that company having been exchanged for a similar number of shares of a nominal value of £2 10s. each, while their 8 per cent. debentures have been replaced by 4 per cent. debentures, guaranteed both as to capital and interest by the Brazilian Submarine Telegraph Company, Limited. The Postal Telegraph Cable Company, some of whose shares we recently acquired, has been taken over by the Commercial Cable Company, the shares of the former company being exchanged for 4 per cent. debentures in the latter, £103 of these debentures being given in exchange for every £100 nominal of shares in the Postal Telegraph-Cable Company. Since the last meeting the company's investments have been distributed over a larger area. A change has been made in the manner of presenting the accounts relating to the company's investments; the stocks and shares held by the company now appear at their actual cost, the difference between the profits and losses on securities realised since the formation of the company being shown separately on the balance-sheet, instead of being deducted from, or added to, the cost price of new premises, as heretofore. The present market value of the securities now held by the company considerably exceeds the cost after taking into consideration the deficiency resulting from previous sales and exchanges of investments. In conformity with the articles of association, one of the directors, viz., the Most Hon. the Marquis of Tweeddale, retires, and, being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., and Mr. William Griffith, B.A., barrister-at-law, also retire, and offer themselves for re-election.

City and South London Railway Company, Limited.

The report of the directors for the half-year ending June 30th, 1897, to be submitted to the 26th ordinary general meeting of the company, to be held at Winchester House, Old Broad Street, E.C., on Thursday, July 29th, at 12 o'clock noon, reads as follows:—The receipts from all sources for the past half-year have amounted to £28,259 12s. 6d., and the cost of working has been £15,733 17s. 11d., leaving a profit of £12,525 14s. 11d. Inclusive of the balance brought forward from December 31st last, the net revenue account shows an aggregate total of £13,888 1s. 1d. After making provision for the debenture and debenture stock interest, and the deduction of £1,000 referred to in paragraph 8, a balance remains available for dividend of £9,439 14s. 1d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 2 per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,034 19s. 1d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season ticket holders, carried since the opening of the railway in each half-year:—

Half-year ended	Number of passengers (exclusive of season ticket holders).	Receipts (including season tickets).
		£ s. d.
December 31st, 1890 (11 days)...	165,000	1,568 3 9
June 30th, 1891	2,412,343	19,403 6 9
December 31st, 1891	2,749,055	19,798 16 6
June 30th, 1892	2,813,162	20,931 4 2
December 31st, 1892	3,117,602	22,002 17 5
June 30th, 1893	3,146,656	22,458 6 9
December 31st, 1893	3,093,351	22,067 14 10
June 30th, 1894	3,383,154	23,564 10 0
December 31st, 1894	3,275,649	23,540 12 4
June 30th, 1895	3,113,199	23,711 5 8
December 31st, 1895	3,172,438	23,780 3 7
June 30th, 1896	3,192,672	24,021 13 0
December 31st, 1896	3,368,480	25,567 7 6
June 30th, 1897...	3,437,810	26,403 3 6
Total since the opening of the line	40,440,571	£298,819 6 3

The locomotive, generating, and hydraulic plant have been efficiently maintained and are in good working order and condition. Considerable progress has been made with the works of the extension to Finsbury Pavement. The shafts at London Bridge and Moorgate Street Stations have been sunk to the full depth, and the driving of the tunnels commenced. The difficulty experienced as to the settlement with the rector and churchwardens of St. Mary Woolnoth for the acquisition of the church for the construction of the station underneath, compelled your directors to apply to the Board of Trade in order to obtain possession in accordance with the Act of Parliament. By direction of the valuer appointed by the Board of Trade a large sum having been deposited with the Paymaster-General as security, possession of the site was at length obtained in May last, and the works are now being proceeded with. In pursuance of the authority given at the last half-yearly meeting, notices to treat are being served upon the owners of the property required for the two stations on the extension to Clapham. Arrangements have been made with Sir Benjamin Baker to act as engineer, and the detailed plans for the line are now in hand. The net profit of £1,000 received from the letting of seats to view the Diamond Jubilee Procession has been transferred to a reserve fund to assist in meeting any dividend that might accrue on the preference shares created in connection with the extension, should there be any delay in the opening of the new line for traffic. The further sum of £1,800 has been paid off the five per cent. terminable mortgage debenture bonds during the past six months, leaving a balance of £28,300 still to mature. The dividend warrants will be posted on the 6th proximo, and payable on the following day."

Telegraph Construction and Maintenance Company, Limited.

A half-yearly general meeting of this company was held on Tuesday at the offices, Old Broad Street, Sir Robert Herbert presiding.

The Chairman stated that at their meeting at the beginning of the second half of the year no formal business was placed before them, and that there was no report or statement of accounts presented to them, as these were made up to the end of the year, and submitted to the meeting in January. The only object of calling them together that day was that they might hear about the condition of their property and the business that had been transacted during the past six months. Both the factories were in good working condition, and they had done a fair amount of business during the half-year. The ships had also been tolerably well employed, and were in a thoroughly good condition. The state of the company's affairs, therefore, warranted their offering to the shareholders an interim dividend of 5 per cent., or 12s. per share, as in previous years, and, without prophesying, they hoped that nothing would prevent them from paying the same dividend next January as they paid last January. The construction of cable had gone on steadily by them as regarded furnishing supplies to the various companies who required their stocks increased, but they had had no great transaction to address themselves to. Some of them might have seen at the Imperial Institute a very interesting exhibition, which had been placed in the north gallery by the company, and which had attracted a great deal of attention—he referred to the admirable model of the system for communicating by telegraph without a complete connexion by wire between the Fastnet Rock and the mainland—a system prepared by Mr. Willoughby Smith and Mr. Granville, showing how a message can be passed through rough and broken water from one point to another without any actual wire to convey it.

The Direct United States Cable Company, Limited.

The directors' report for the six months ended 30th June, 1897, to be presented to the fortieth ordinary general meeting of the company, to be held at Winchester House, on Tuesday, July 27th, at two o'clock, p.m., reads as follows:—"Herewith the directors submit the usual statements of account for the half-year ended June 30th, 1897, which, with the half-year's accounts to December 31st last, presented at the ordinary general meeting on January 26th last, show the financial result of the twentieth year's working of the company. The half-year's revenue, after deducting out-payments, amounted to £43,892 8s. 3d. as compared with £42,456 11s. 9d. for the corresponding period of 1896, being a difference of £1,435 16s. 6d. in favour of the half-year under review. The working and other expenses for the same period, including income-tax, but exclusive of cost of repairs of cable, amounted to £19,559 15s. 5d., leaving a balance of £24,332 12s. 10d. as the net profit of the half-year, making with £4,843 10s. 6d. brought forward from the previous half-year a total of £29,176 3s. 4d. For the corresponding period of 1896, the working expenses and other payments amounted to £19,692 4s. 2d. Three quarterly interim dividends of 2s. 6d. each per share, amounting to £22,766 5s. have been declared and paid during the financial year, and a final dividend of 2s. 6d. per share is now proposed, together with a bonus of 2s. per share, making, with the three interim dividends, three per cent. for the year, being a total distribution of £36,426. After transferring £4,000 to the reserve fund account, the balance of £3,927 13s. 4d. on the revenue account is proposed to be carried forward. The reserve fund account has been debited with £1,540 9s. 5d. for cost of cable repairs, and with £2,000 written off the Ballinskelligs buildings account, and after being credited with interest on the investments, profit on security sold, and sum transferred from revenue account, the balance of the reserve fund now amounts to £338,488 15s. 8d. The additions and improvements to the staff buildings at Ballinskelligs, which have been in progress for some time, are expected to be completed within the current half-year. Pursuant to the provisions of the articles of association, two of the directors, viz., Sir James Pender, Bart., M.P., and Charles E. Günther, Esq., retire by rotation, and, being eligible, offer themselves for re-election. Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. J. and J. Sawyer & Co., the auditors, retire pursuant to the articles of association, and offer themselves for re-election."

National Motor Carriage Syndicate, Limited.

A prospectus has been issued of this company, which has a share capital of £30,000, the present issue being of 12,000 shares of £1 at par. The objects of the company are to acquire for traction and motor carriage purposes the entire rights of the United Kingdom in the storage battery employed by the Sussmann Electric Miners' Lamp Company, Limited, for their portable electric miners' lamp. Also certain inventions of Mr. H. F. Joel, A.M.I.C.E., consisting of an electromotor of high efficiency, specially designed for the propulsion of vehicles, and a new and improved gear for transmitting the power, for which inventions four patents for the United Kingdom have already been granted, and three others protected. To apply the above combined inventions to suitable carriages and vehicles, and to publicly demonstrate the utility and practicability of the same. To realise the above inventions by the sale of the patent rights to another company (or otherwise) at a sum which shall yield a substantial profit to the shareholders herein.

The secretary is Mr. V. C. Doubleday, and the offices are at 37, Walbrook, E.C. Mr. S. A. Rosenthal is the consulting engineer and electrician.

National Electric Free Wiring Company, Limited.

The prospectus of this company is now before the public, as the list closes, for both town and country, to-morrow (Saturday). The capital is £250,000, in £1 shares, of which 235,000 are now offered for subscription. The company has been formed for the purpose of carrying out the wiring and fitting of premises for the electric light in consideration of an annual payment. It is well known that the great obstacle in the way of a largely extended use of electricity in this country is the heavy outlay entailed upon the consumer for the wiring and fittings. This obstacle will now be removed, as a would-be consumer of electricity can have his premises completely fitted up by the company without any initial charge whatever. This company and the local supply authority will work the system hand-in-hand for their mutual benefit. The main advantages claimed for the system are:—It is within the power of any occupier in a district worked by this company to have electric light without initial outlay; the supply authorities will collect the charge for wiring with that for the light itself, so that this company will have no expense of collection; the working capital of the company will be expended in work producing an immediate return, as each installation, when completed, will immediately become profit-earning: the company will commence a remunerative business at once, without passing through the experimental stage; this company will acquire the contracts, licenses, stock, plant, goodwill and other assets, except cash balances, of the Electric Free Wiring Syndicate, Limited, which was formed for the purpose of fully testing the working of the system in the district of Wallasey, in Cheshire, where the first contract for free wiring was made with the District Council.

The syndicate have arranged terms of contracts for free wiring with the London Electric Supply Corporation, Limited, the St. James's and Pall Mall Electric Supply Company, Limited, the Notting Hill Electric Supply Company, Limited, the South London Electric Supply Corporation, Limited, the Corporation of West Ham, the Shoreditch Vestry, the Corporation of Worcester, the Corporation of Blackpool, the Wallasey District Council. The syndicate have acquired from the British Insulated Wire Company, Limited, of Prescot, Lancashire, and transfer to this company the exclusive right to the use throughout the United Kingdom of that company's patented cables and other appliances so far as the same relate to house wiring. It is estimated that, after making provision for payment of the cash consideration to the vendors, equipment of show rooms, and other necessary initial expenditure, the company will, from this issue, have sufficient available capital for the equipment of 266,600 lamps of 16 candle-power, or their equivalent, at an average cost of not more that 15s. per lamp. If this outlay were to yield only the minimum return mentioned above at the rate of 1s. per 8 candle-power lamp, it is stated that the revenue of the company would thus be £26,660. Deducting from this the general management expenses, including directors' fees, estimated at £3,500, there would remain a balance of £23,160 available for depreciation, reserve fund, and dividend. The purchase price to be paid to the syndicate for the business, patent rights, stock, plant, and benefit of agreements has been fixed by the contract at £30,000. Directors—R. Stewart Bain, C.A., William R. Davies, George Ellis, J.P., James T. Jervis, M.Inst. C.E., F.R.G.S., J. W. Swan, F.R.S.; secretary and offices (pro tem)., H. J. Nisbett, 11, Charing Cross Road, London, W.C.

The Edison & Swan United Electric Light Company, Limited.—Accounts for the year ending June 30th, 1897, have been considered by the directors, who have determined to recommend the payment of a dividend in respect of the six months ending June 30th, 1897, at the rate of 6 per cent. per annum, on the "A" share capital of the company as now paid up, carrying forward about £8,500 as against £5,300 in the previous year. The above distribution, together with the interim dividend, at the rate of 5 per cent. per annum, already paid in February in respect to the first half-year, will be equal to a dividend of 5½ per cent. for the entire year. The dividend warrants will be posted on August 12th, 1897.

British Aluminium Company.—The directors announce that warrants for the payment of an interim dividend at the rate of 7 per cent. per annum on the cumulative preference shares of the company have been posted.

Westminster Electric Supply Corporation.—The board have declared an interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30th last, payable on September 1st to all shareholders on the register yesterday.

It is interesting to note that the interim dividend for the first half-year of 1896 was only 6 per cent. per annum. From this it would appear that good progress is being made, and that if all goes well, the total division for 1897 should exceed the 9 per cent. of 1896.

National Telephone Company, Limited.—The directors have resolved, subject to final audit, to recommend, at the forthcoming general meeting of shareholders, the following dividends for the half-year ending June 30th last:—At the rate of 6 per cent. per annum, less income-tax, on the first and second preference shares; at the rate of 5 per cent. per annum, less income-tax, on the third preference shares; at the rate of 6 per cent. per annum, free of income-tax, on the ordinary shares, carrying £35,000 to reserve, and about £6,000 forward. The transfer books of the company will be closed from the 17th to the 29th inst., both days inclusive, and the dividend warrants will be posted on the latter date.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing a sum of £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending June 30th, 1897, of 14s. per cent. on the ordinary stock, and £1 8s. per cent. on the preferred stock, less income-tax, payable on July 31st, to the stockholders registered on the books of the company on July 13th, 1897. After paying the foregoing dividends, there will be a balance of about £8,500 to be carried forward to the next account.

Stock Exchange Notices.—The Stock Exchange Committee have appointed Wednesday, July 28th, a special settling day in City of London Electric Lighting Company, Limited, provisional certificates for a further issue of 10,000 ordinary shares, Nos. 80,001 to 90,000, and ordered same to be quoted in the Official List also.

The City of London Electric Lighting Company, Limited.—Warrants for the interim dividend on the 6 per cent. preference shares, payable for the six months ended June 30th last, were duly posted on the 19th inst.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 18th, 1897, were £844; week ending July 19th, 1896, £857; decrease, £13; total receipts for half-year, 1897, £2,777; corresponding period, 1896, £2,675; increase, £102.

The Great Northern Telegraph Company. The receipts in June, 1897, were £22,800; January 1st to June 30th, 1897, £136,800; corresponding months, 1896, £139,600; corresponding months, 1895, £149,200.

The Liverpool Overhead Railway Company. The receipts for the week ending July 18th, 1897, amounted to £1,506; corresponding week last year, £1,267; increase, £239.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 16th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,397.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME,	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, July 14th.	Closing Quotation, July 21st.	Business done during week ended July 21st, 1897. Highest.	Lowest.
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	99 —103	99 —103	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5 — 6	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	55 — 58	55 — 58	...	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	100½— 101½	100½—101½	101⅜	100⅜
3,038,920£	Do. do. Defd.	Stock	...	...	...	10½— 11	10½— 10⅝	11⅛	10½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15 — 15½	15 5/16	15
75,000£	Do. do. 5 %, Debs., 2nd series, 1926 ...	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3½— 3⅝	3½— 3⅝	3½	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	170 —175	170 —175	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106½—107½	106 —107	107	106½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16— 1/16	1/16— 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9 — 10	9 — 10	9⅛	9⅛
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½— 10½	9½— 10⅝	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%xd	103 —106 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9⅜— 10⅛	9⅜— 10⅛	10⅛	10
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 — 17½	17 — 17½	17⅜	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19	18 11/16	18⅝
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	103 —106	103 —106	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	128 —131	128 —131	128⅞	128
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7½	17⅜— 18¼	17⅜— 18¼xd	18	17⅞
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 —103	99 —103	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	130 —133	130 —133	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 —103	99 —103	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%	107 —110 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½— 12	11½— 12	11⅞	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17 — 17½	17 — 17½	17⅜	17 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10¾	25½ — 26⅔	26 — 27	27	26½
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5⅞	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	53 — 56	54 — 57	54½	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅜— 6⅞	6⅞— 7⅛	7 1/16	6⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16½	16
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16½	15½
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 5/16	6⅛
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	103 —107	105 —110	108	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅜— ⅜	⅜— ⅜	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	*nil*	5 %	5 %	7 — 8	7 — 8	7⅛	...
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¾— 4½	3½— 4 xd	3⅝	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	98 —104	99 —104	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	4 %	nil	5 — 6	5 — 6	...	...
213,400	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	101 —104	102 —105	103½	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	8½— 9	9 — 9½	9⅜	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¾— 7½	6¾— 7½	7	...
33,129	Do. do. do. Def. Ord ...	7½	1 %	1 %	...	2 — 2⅜	2⅛— 2⅜	2⅛	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	99 —102	100 —103	102½	101½
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	⅞— 1⅛	⅞— 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10½— 10⅝	10½— 10⅝	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	104 —108	104 —108	...	...
160,100.	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	13 — 14	13 — 14	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	9⅜— 10½	9⅜— 10½	10⅛	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	110 —113	110 —113	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½ — 24½	23½ — 24½	24	23⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	16½— 17½xd	17½	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	131	130
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	*nil*	*nil*	12⅜— 13¼	12⅜— 13¼	...	...
10,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	15 — 15½	15 — 15½xd	15 5/16	15 1/16
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	14⅜— 15½	15 — 15½xd	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8½— 9	8½— 9	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½— 17⅛	16½— 17½	17⅛	16½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	15½ — 16⅝	15 — 16 xd	16	15⅝
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —122	118 —122	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	15 5/16	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15½ — 16½	15½— 16½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅞	10⅝
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	5 %	7 %	9 %	15 — 16	15 — 16	15⅝	15½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years.			Closing Quotation, July 14th.	Closing Quotation July 21st.	Business done during week ended July 21st, 1897.	
			1894.	1895.	1896.			Highest.	Lowest
20,000	British Electric Traction	10	...	...	...	11¾ — 12½	12¼ — 12¾	12¾	12½
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	5	2½%	...	...	1⅝ — 1⅝	1⅝ — 1⅝	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅝ — 1⅝	1⅝ — 1⅝	1 7/16	...
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	105 —109	105 —109	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	93 — 97	93 — 97	...	...
13,126	Central London Railway, Ord. Shares	10	...	...	...	9¾ — 10¼	9¾ — 10¼	...	...
143 10	Do. do. do. £6 paid	10	...	...	...	5¾ — 6¼	5¾ — 6¼	...	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1⅜	1¼ — 1⅜	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	...	...
630,000	City and South London Railway	Stock	1⅛%	1 1/16%	1 1/16%	62 — 64	62 — 64	64¼	62⅜
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	½ - 2	1½ - 1⅝	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2¼ - 2⅜	2¼ - 2⅜	2 9/16	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3½ — 4½	3½ — 4½	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	5½%	1⅝ — 2	1⅝ — 2	2	1 15/16
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ..	2	7 %	7 %	7 %	2⅜ — 3¼	2⅜ — 3¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅜ - 1	⅜ — 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ..	2	*nil*	...	...	½ — ¾	½ — ¾	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ..	10	*nil*	10½%	..	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	18½ - 19½	19½	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	18 9/16	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	..	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ - 21½	20½ - 21½xd	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	..	...	105 —108	105 —108	...	...
27,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	2 7/16 - 12 9/16	12⅜ 12½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16	15½ — 16	...	...
37,25	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	37 — 40	36 — 39	39	37½
150,00	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105 xd	104½	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ — 11¼	10⅜ — 11¼	...	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1894—3%; 1895—3%; 1896—3%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9¼.

Electric Construction Corporation, 6 % Debentures, 102—105xd.

House-to-House Company, 7 % Preference, of £5, 10¼—10⅜xd.

Do. do. 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅝—2.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2 per cent. (May 13th, 1897).

ELECTRIC MOTORS IN THE NORTHERN PACIFIC R.R. SHOPS.

Electricity is used to drive all the machinery in the shops of the Northern Pacific Railroad at Edison, in the Far West. Recently, says the New York *Electrical Engineer*, the completion of the long distance transmission line between Folsom and Sacramento, Cal., has placed it within the power of the Southern Pacific Railroad to use motors in their shops at Sacramento with most satisfactory results. In their operation the motors have already shown considerably economy over that of the original steam plant which they superseded. The motors are placed in the shops where steam engines had previously been used, and the difference between the results obtained, apart from the mere question of economy, is marked.

Three motors are used; the first a direct current motor, placed upon a transfer table used for shifting the locomotives. The motor is a G.E. 800, similar in every respect to those used on the ordinary trolley car, and it is driven by 500-volt current from the railway station. It is so geared that it operates not only the table, but also drives a drum carrying a wire cable, used to haul the locomotives upon the table. This it does with perfect ease, hauling all sizes of locomotives. Instead of taking the current from the overhead wire by means of a trolley, the conductors are laid in an underground conduit, and the contact is made by means of a plow running in this conduit. Some fears were at first expressed as to the result in rainy weather; but although considerable rain has fallen since the installation of this motor, no difficulty has been experienced.

The motor used to operate the machinery in the boiler shop, as well as in the tender shop, is a 50 horse-power motor, driven by 440-volt current from the step-down transformers. The machinery in these shops is peculiar, in that each machine is provided with a heavy fly-wheel for carrying it over the sudden shocks which occur in punching and shearing, and similar work. For three or four seconds the motor has an excessive amount of work upon it in starting the machine from idleness, and until the maximum speed is acquired. The load then drops to 30 horse-power. Such sudden drops as this are calculated to demoralise motors of ordinary construction; with the induction motor the drop in the load is hardly noticed.

The spring shop is driven by a 10 horse-power motor; this motor also has to cope with sudden heavy loads. In this shop all the springs—spiral, elliptical and leaf—used in the construction of locomotives, &c., are made, and the most difficult piece of work done is the making of the spiral springs, some of which come to the machine as a bar of red hot steel 1¼ inches in diameter. This is placed in the machine, is instantly wrapped around a mandrel, and it is such work as this that throws for a few seconds an enormous load on the motor. Although it has been in use for some time, it shows no sign of strain.

The two motors last named are of the General Electric Company's three-phase induction type, without commutator, collecting rings, or brushes. They are driven by 440-volt three-phase alternating current from the transformers, which step-down the 11,000-volt current transmitted 24 miles from the generating station at Folsom. This installation is only one of many made since the completion of the transmission from Folsom to Sacramento, which latter city is rapidly becoming dependent on electricity as its exclusive motive power.

THE MUNICIPAL ELECTRICAL ASSOCIATION, 1897.

(*Continued from page 99.*)

DISTRIBUTING SYSTEMS.*

By J. R. Blaikie, A.I.E.E., Chief Assistant Electrical Engineer, Bristol.

The most economical and efficient means of transferring electric energy from the generating source, to indefinite points, in indefinite quantities, and at variable times—is beyond human calculation.

The result of each experiment, and the experience of each year, tends to narrow the limits of speculation, but at the best there must always be a considerable element of uncertainty.

The first cost of a system and maintenance, the capability of subsequent development and the probable dissipation of energy, whether in ohmic resistance, iron losses, or simple leakage, are not the only difficulties of the problem. There are certain other little considerations graced by Acts of Parliament concerning uniformity of pressure, and such devices and alternative methods of supply, as the engineer may think desirable for securing the reliability of the service.

To the practical engineer the last two points are of vital importance, and having secured these, he may then proceed to the luxury of cutting down the costs of distribution.

Considering various systems on broad lines, with special regard to the more pressing requirements, one cannot help regretting (with all due deference to the Board of Trade), that aerial lines are no longer permitted. It does seem a little hard when overhead tramway conductors, 600 volts, bare copper! and an "earth" return! are encouraged to increase and multiply.

Since the high voltage lamp has been produced, the idea becomes still more practicable. There is no other system so readily capable of extension, and the rapidity with which alterations can be made, is a great convenience, both to the undertakers and to the general public. The difficulties of insulation were fairly well overcome five years ago, and no doubt there would be perfections forthcoming to-day, if demanded. The mechanical difficulties are less than those involved in tramway systems. Happily the Board of Trade does not issue regulations on the lines of the Medes and Persians, so there may come a day when small country towns and straggling districts will be able to support the cost of an electric current service.

It would take too long to trace the true historical development of underground systems. The first stage appears to be conductors strained from point to point on insulators in culverts. It speaks well for the perseverance and ingenuity of electrical engineers to find that a system with so many obvious difficulties can still hold its own. It is almost mysterious to find high efficiencies when one considers the probability of leakage and the cost of running ventilating fans, &c. The dangers of electrolytic action, and the chances of explosion, seem to be greater with a culvert system than in any other, and may have a powerful influence in the future in condemning it, as safer methods are brought forward and proved.

The construction of culverts in ground already full of gas pipes and water mains, to say nothing of telegraph and telephone lines, pavements undermined by coal cellars, or an occasional church crypt, must necessarily be a very laborious undertaking. If the area to be supplied is of an undulatory character, and the difference of level extreme, the difficulties of drainage become more serious.

India-rubber covered cables drawn into pipes have been and still are very successful for high tension work. Manholes receiving the ends of the pipes are not very nice, and are liable to fill with water, but the main point for criticism is the rubber. Whether it is possible or not to make rubber that will not perish is perhaps only known to manufacturers. Competition with less expensive dielectrics may be responsible for research work that is not altogether in the interest of the user.

Cables insulated with cotton or similar material drawn into pipes full of heavy oil have been used in a few cases. Such a system does not commend itself on account of complications involved in glands and fluid light joints.

Bitumen casing eliminates many of the objections to culverts and pipes, but it does not appear to have been very generally employed. Perhaps the cost is excessive, or the friction on the cables drawn in is a disadvantage.

All the above systems are capable of development as the demand increases, and enable the outlay in copper to be efficiently controlled.

Solid systems mean laying in copper for the ultimate supply. More of this hereafter.

The Callender solid system, mains covered with bitumen and braid, laid on wooden bridges in iron troughs, and filled in solid with bitumen, appeals to the engineer as a sound mechanical job and easy to manipulate. Still there is a tendency for a gradual flow to take place in a substance like bitumen, which might cause trouble. The light cast-iron covering used would not be much protection from a pick in the hands of the average navvy. In the case of alternating currents, there may be a fair amount of energy wasted in eddy currents in the iron troughs. By far the most popular solid system is the lead sheathed armoured. There are at least 56 undertakings in Great Britain using these cables in some form or other.

The table following is compiled from data published by the *Electrician*. In some cases the description of mains given is somewhat incomplete, as for instance, "Insulated cables drawn into pipes." These have been taken as rubber covered. Stations having two or more kinds of mains have been counted to each variety. The date of the opening of the station is given, but that of the inauguration of new kinds of cable is unfortunately omitted.

Year of opening.	Bare copper.	India-Rubber.	Bitumen casing.	Solid bitumen.	Lead and armoured.
1882	...	1			
1885	1	1			
1886	...	...	...	...	1
1887	...	...	...	1	1
1888	1	...	...	1	1
1889	1	1	1	1	4
1890	2	4	2	1	2
1891	4	1	...	...	3
1892	2	5	1	...	3
1893	6	8	1	1	8
1894	2	5	2	2	11
1895	2	7	1	1	12
1896	...	2	...	...	4
High tension	1	16	4	4	31
Low tension	21	12	4	4	25
Total	22	38	8	8	56

There can be little doubt as to the reliability and cheapness of a system so largely adopted.

It may be of interest to this Association to dwell more particularly on the details of this rapidly-increasing means of distribution.

The majority of lead sheathed cables are entirely dependent on the watertight protection of the lead casing for the maintenance of the insulation. The quality and uniformity of this casing is therefore the most questioned and the most keenly watched. The percentage of foreign material or use of an alloy may or may not be advantageous. Some makers put the casing on hot. Variations in temperature may be of importance to the insulating material. Others prefer to use hydraulic pressure and put it on cold. What the chances are of getting porous places through dross, oxidation, or crystalisation by one process or the other is a matter of opinion.

(With a view to discovering porous places it might be well to put on a thousand volts or so continuous current for a few hours while the cable is under water, the positive pole to the tank and the negative to the core. As is well known the passage of a current alters the surface tension of fluids, and by this means the water would percolate rapidly and produce the results that might occur in the course of a few years, or by a similar accidental conditions in practice).

The ductility of the metal is of great importance as the latter processes of manufacture and the laying subject the whole cable to a good deal of bending. The differences in the diameter of the cores of the drums used by various makers is rather noticeable. The jointing and tapping of these cables can be made perfectly reliable and simple. Of course some methods are better than others. In general there appears to be room for improvement in ensuring the continuity of the lead and armouring, or the connection of either to junction boxes for the purpose of making a certain "earth." The extraordinary differences of potential that have been found to exist across a few feet of ground point a strong necessity. The use of "wiped" plumbers' joints from the lead sheathing to a lead sleeve, or from the sheathing to a brass collar from a box, is not very satisfactory. It requires a specially skilful plumber to make a thoroughly sound joint in the awkward positions that occur. It is difficult to say whether a joint is sound, and it may get damaged as the box settles into its final position. It is also awkward passing the end of a cable through a collar and making connections inside the box.

A box split into two halves to fit on after the internal work is complete is far more convenient. The two halves are made with a tongue and groove; a bit of thin lead piping laid in the groove makes the joint quite tight when bolted up. With jute cables the box can be filled with oil, in which case a small compartment at each end is filled with melted compound to make the ends tight. In house boxes, if rubber is used for the lead in cables, the whole box must be filled with compound, as the oil attacks the rubber. It is generally better, however, to make all joints with compound.

The internal fittings should have rings vulcanised in position and ebonite caps on any portion that could possibly come in contact with the box through violent mechanical strains. Some jointers are not sufficiently careful to see that there is solid ground or a large stone underneath the box, the result being that when the earth is filled in and pounded down, the fittings are liable to very severe strains, or the box may slide along the cable a little, and bring one end in contact. "Dead ends" require attention with regard to these strains. It is common enough to tape the end, slip a lead socket full of melted compound over it, and then a piece of iron pipe. In the course of time the lead gets forced down until at last the tape cuts through and causes an "earth."

Some makers impregnate the insulating material with a heavy oil, which has the advantage of healing a slight puncture in the lead, and possibly makes the cable more flexible, by allowing the layers to slip slightly when bent. Whatever this may be worth, it is obviously safer to get the most perfect lead sheathing as well.

Other makers have non-hygroscopic insulating material, which is also more or less independent of the lead. The two latter varieties have one great advantage, viz., if by accident the cable should get pierced, there is less chance of a great length being spoilt, as with the ordinary jute cables moisture may run up any distance if it once finds an entrance.

The armouring applies to all makes, and might be improved. There are three usual methods:—

* Read Friday, July 2nd, 1897.

1. Iron or steel wire in long spirals.
2. Wire with special sections that locks itself.
3. Two steel tapes, breaking joint.

Round wire spirals offer very little resistance to pointed tools, as the wire easily spreads.

The other two are perhaps equal in resisting, but hardly enough. It might be better to provide more elasticity, by putting a serving of jute between the layers of tape, or perhaps wire, between them. Provided that the armouring cannot buckle and pinch the lead when the cable is bent, it would be well to have it of such a stiffness that the cable could not be bent too sharply, and thereby gain extra resistance to penetration; the additional weight would not be a great drawback.

So much for cables, arrangements for disconnecting sections; transformer pits or sub-stations are leading features.

The first difficulty is to make such receptacles or chambers watertight; the next step to ensure their being free from gas, either coal gas, which may accumulate from the soil charged continually by small leakages, or the explosive product of electrolysis, and the third, how to prevent hydroscopic insulators or walls from falling below the temperature of the enclosed air.

Moisture in the air does not matter unless it deposits. Small boxes and transformer pits can be made of metal with sound mechanical joints and glands; they can be quite watertight and gas proof. With regard to moisture depositing, the simplest plan is to exclude the air altogether by filling them up with oil; but this, of course, prohibits the use of rubber cables.

A cleaner and still satisfactory way of making junction boxes reliable is by having the detachable links or fuses carried up to one level, as near the top as possible, and then filling in compound up to the level of the links. By this means the enclosed air space can be reduced almost to insignificance. A rubber joint can then be used, which if of good material, will last for several years. Of course, either gun-metal studs or nuts, or both, should be used for the inner cover. A cast-iron tray, filled with limmer, makes about the best outer covering.

A great objection to all out-door boxes is that they are more or less inaccessible in wet weather. They necessitate having a tent, or similar protection, which means time, and there are occasions when time is everything in a lighting station. Where transformers are used, a large number of capacious dry sub-stations are invaluable as disconnecting junctions and branch fusing points.

Various modes of construction seem to have been employed in the building of underground chambers. Of course, a lot must depend on the natural drainage of the ground. The commonest plan is to build double walls, have a space from 1 to 2 inches in between, filled with hydraulic cement, bitumen, or pitch. In some instances these walls are 4½ inches, and in others 9 inches. Chambers about 7 feet by 7 feet by 6 feet inside of this type, cost from £50 to £60. Puddled clay outside the walls has been used, but the cost is not given.

Cement concrete, having asphalte lining, costs about £70. Cement concrete, heavily faced with cement, only £28. Good dense bricks, laid in cement, 18 inches thick, cost about £65.

One of the latest methods, and the cheapest, is the use of concrete with glazed tiles, having an L-shaped section. A glazed surface, with fine joints in cement, makes an ideal watertight structure. The cost is about £25. Fortunately an engineer using these sub-stations has sent full details, so that the cost in districts paying different rates of wages can be estimated very accurately.

The roofing is a very important detail. The changing differences of temperature between the inside and the outside tends to make the roof "sweat." The brick arch has the advantage of running this condensed water down the sides instead of allowing it to drop on the apparatus.

Rolled joists and concrete is more efficient as regards space, and cheaper to construct. It also affords a better means of attaching the man-hole frame. A variety of this roof consists of old paving stones with rolled joists. A little cement in the joints makes it very waterproof. It is economical as well, and the suggestion of utilising the waste material from the Corporation yards will generally meet with unqualified approval.

With a view to keeping the roof dry independent of ventilation, some roofs have been constructed in the following manner:—One inch flooring boards treated with creosote are laid on 2-inch × 3-inch wood joists. Over this is laid sheet roofing lead with soldered joints quite flat, and the edges well over the outside of the walls. Sand to a depth of 2 inches is laid over the lead, and then the iron joists and concrete. The wood being non-hygroscopic, keeps the inside dry. It could not do any external damage if by any extraordinary means it should take fire. As an extra precaution, the woodwork can be painted with asbestos paint, if thought desirable. It is very convenient to have chambers that will keep dry without ventilation, as many ventilating systems are not very positive, and where relying on the heat of transformers, an independence that will allow of cutting alternate feeding points out altogether in the summer months is a consideration. Ventilation is, however, often of the greatest importance in keeping sub-stations dry, and may be necessary in some cases to ensure the chamber being free from gas. The means taken to render a chamber waterprof, often make it gas-proof as well, in such cases, if no pipes leading in cables, &c., are left open, it is practically impossible for trouble to arise from this source.

In a few isolated cases fans are used; the cost of this mode must be greatly against it. When transformers are employed in a system, the heat generated is sufficient to make a very fair circulation either through special covers or pipes. With covers, the necessity of providing a drip pan makes the arrangement rather clumsy. With pipes it is very hard to discover the most advantageous position and size. There is nothing to be gained by carrying the up-cast pipe any distance up a wall or post, as the pipe itself dissipates the heat so rapidly. Pipes taken into a small well in the pavement are not much use either. Good results have been obtained by pipes 3-inch × 4½ inches, ending in a grating standing against a wall about 6 inches to 8 inches above the ground. The two pipes, in one casting, go down vertically about 2 feet 6 inches, the one with a right angle bend runs horizontally about 2 feet, and enters the chamber near the top, the other, with two bends, is taken to within a foot of the bottom. With a ventilator of this sort the flame from a match is drawn in well by the downtake pipe, and repelled by the up-cast.

In illustration of some of the above remarks, the following experimental results are interesting:—

A maximum and minimum recording thermometer was placed in a sub-station, and a similar one outside. Readings were taken at the end of about three days on both instruments. It would, of course, be far more accurate to register the relative temperatures simultaneously at short intervals; but the ends to be gained would hardly justify the necessary expense.

In the diagram the thick lines represent the range outside, and the dotted lines the range inside the sub-station.

The first case is a sub-station, with a roof of cement, concrete, and iron joists and stone flagging, but no wood, the inside being faced with neat cement. Ventilation by means of two 2-inch pipes into a well in the pavement, this chamber contains two 25 kw. transformers; the roof sweats a good deal. It will be noticed that the mean temperature inside varies pretty much as the mean temperature outside. The ventilation being poor, this result is due to the conductivity of the roof.

Cost of Building Construction of Sub-Stations.

Internal dimensions.	Wages.	Carting.	Tiles.	Cement.	Girders.	Roof slabs.	Covers and ventilators.	To al.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
11′ 6″ × 4′ 9″ × 5′ 6″ deep ...	5 12 6	3 9 0	6 1 0	2 12 6	1 4 6	0 15 0	4 19 6	24 15 0
11′ × 5′ × 6′ „ ...	5 14 8	1 16 6	5 17 0	2 11 2	1 4 6	0 15 0	4 15 6	22 14 4
14′ × 5′ × 5′ 9″ „ ...	5 4 11	1 7 0	7 7 0	3 4 9	1 4 6	1 0 0	5 7 6	24 15 8
11′ × 5′ × 6′ „ ...	8 16 9	1 6 0	5 17 0	2 11 2	1 4 6	0 15 0	3 14 6	24 4 11
11′ × 5′ × 6′ „ ...	5 9 0	1 2 0	5 17 0	2 11 2	1 4 6	0 15 0	3 13 0	20 11 8

Roof slabs—old paving stones—at 2s. 6d. per yard super. Tiles, cream glazed, 8d. each. Cement, 4s. per bag. Concrete, 1 to 6. Labour, 4d. per hour. Bricklayers, 6½d. per hour.

The next case is a similar chamber, but having wood in the roof, and 6-inch ventilating pipes, also into a well. Here the temperature remains constant inside. The condition of this chamber is always first-rate. There is a little ventilation, as is shown in case III., which is the same chamber with the ventilators blocked, a slightly high temperature is reached.

I.—Redcliff.		II.—Victoria Street.		III.—Victoria Street.		IV.—Woodland Road.	
Outside.	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	Inside.
				Ventilator	Blocked.		
43°-61°	78°-83°	36°-65°	79°-79°	36°-47°	81°-81°	27°-45°	54°-59°
30°-45°	56°-58°	38°-54°	79°-79°	39°-50°	80°-81°	42°-54°	62°-64°
32°-47°	56°-57°	37°-46°	79°-79°	38°-50°	80°-81°	44°-54°	80°-80°

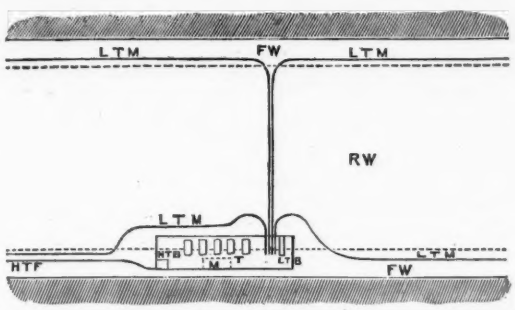
The last case is a later sub-station, having wood in the roof, but a ventilator, as before described, standing a few inches above the pavement. This shows the mean temperature inside to be more or less proportional to the mean temperature outside. This chamber, having a non-conducting roof, owes its varying temperature to ventilation, and is always dry.

Manhole covers are usually designed for special requirements. A large tray filled with limmer, and having a lip to fit into a groove filled with tallow and a little white lead, is in every way satisfactory. A small manhole near one side of the tray should be fitted for ordinary use. The inner cover of the small manhole can be drawn up tight on a rubber joint by a bolt and crossbar, the outer cover being a loose tray filled with limmer. This arrangement is quite weatherproof, can be opened very rapidly, and gives a comparatively clean entrance. If the cover is over any apparatus, it should be lagged inside to prevent "sweating." The floor, above the concrete foundadation, should preferably be of limmer asphalt. This material is quite impervious to water, and has considerable insulating properties.

Although the floor should never be trusted, it might save an accident when handling fuses. The provisions of a reliable "earth" appears to be a serious consideration. As a suggestion, it might be a safeguard to bury a large metal plate under the foundations, and carry up a copper rod which could be also connected with the armouring or lead of cables, or pipes containing cables. A thoroughly systematic way of connecting metal cases, "earth shields," &c., to "earth," seems to be wanted.

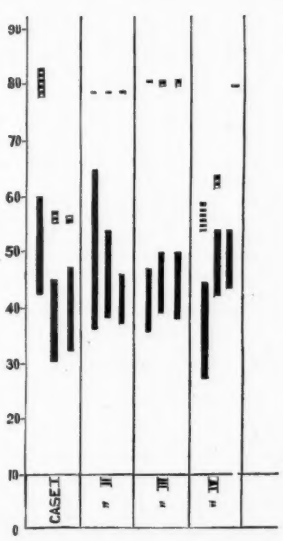
A word with regard to the shape of sub-stations. It is generally more convenient, from the constructional point of view, to form a long narrow excavation along the street, as it can be better accommodated in a network of pipes and other services. In solid systems, if the mains are brought in at the side near one end, space can be economised. A neat arrangement is shown in the diagram.

From data collected from a number of members of this Association with reference to the spacing out of sub-stations, there appears to be such a diversity of arrangement that one cannot draw any definite



F W, Footway; L T M, Low tension main; R W, Roadway; H T F, High tension feeder; M, Manhole; T, Transformers; H T B, H. T. board; L T B, L. T. board.

conclusions. They vary from 100 yards to 970 yards. Probably the want of confidence in the working conditions of underground chamber or the cost of construction has influenced some engineers who prefer to have them "few and far between." The advantages of using sub-stations as junctions are most likely the strongest inducements to those who favour short distances and large numbers. About 200 yards is generally recognised as the efficient distance for three-wire distribution, consequently one would expect to find sub-stations with a 200 yards radius, or 400 yards apart, and this does happen to be the distance given in three or four instances. In outlying districts it may be doubled, with provision for an intermediate station half-way.



For purposes of regulation and alternative methods of supply, it is obviously best to have as many independent feeders from the central station as possible. The original pressure can then be varied to compensate for the individual losses and irregularities of any particular district. The development is often contrary to expectation, so that some means should be provided for correcting the original scheme. For example, three or four feeders, having different sections, should be taken to a distributing sub-station, and connected there to the outgoing cables in the manner best suited to the actual demand. A pipe laid from such a distributing centre to the station, at the same time as certain armoured cables would be convenient for establishing additional circuits or augmenting the section of any existing feeder, by drawing in rubber cables when such alteration should be found necessary.

The number and size of the feeders can only be arrived at from a study of the geographical and commercial characteristics of the area of supply, and modified to suit the personal opinion of the engineer who is responsible for the maintenance. With the actual distributing mains it might be different. Two or three standard sizes might be arrived at, and only the feeding points located, or the pressure raised to accommodate the inequalities demanded.

It would no doubt be a convenience to the users if manufacturers were able to stock such cable instead of having to make up each variety to order. From information received from two large firms as to the usual sizes supplied one can only be astonished to find such a large range. One station alone uses fifteen sizes! of low tension distributing main, others nine, eight, seven, six sizes. Another station eight sizes from ·3875 square inch to ·325 square inch. There are several large stations only using three sizes, and some one or two.

One firm says, "Generally speaking it is not usual for alternating current stations outside London to use a larger size than ·2 square inch or a smaller size than ·1 square inch."

For the sake of the convenience of only storing a limited number of sizes with their joint boxes, &c., one can afford a little margin on the copper. Possibly some attempt at uniformity would decrease the cost of manufacture. From replies received from fourteen provincial stations, the average number of 8 C.P. lamps connected per yard is from 1 to 2·21. Perhaps further data of this kind would enable standard to be determined.

In conclusion, the author desires to thank all those gentlemen and firms who have so graciously responded to inquiries, and to state that he will be glad to add, as an appendix, any further information he may receive with regard to the cross section of distributing mains, or of lamp density per yard of frontage, if any members feel that such figures would be of interest to this Association.

DISTRIBUTING SYSTEMS.*

By Joseph A. Jeckell, A.I.E.E., Borough Electrical Engineer, South Shields.

This is a very wide subject, and of course it is impossible to deal with it exhaustively in the compass of a paper like this, and moreover it is one upon which there must be a very large number of divergent views held by different engineers; the author, therefore, has no intention of laying down hard and fast lines, but merely proposes to open up the ground and afford opportunity for discussion so that each engineer may give his own experience, and thus all may mutually benefit.

The author takes it for granted that the system to be adopted in any one case is that which is most suitable, and that there is no one method which is in every case superior to all the rest.

It follows, therefore, that as very likely the circumstances are entirely different, the systems will in various places also be different, and that which may be very advisable in a densely lighted area may be very unsuitable in a sparsely lighted one.

Again, an engineer who has used one system may be pardoned if he is not anxious to try another, and so he may use that same system in another place for which it may not be so well suited as it was for the place where it had previously been used.

A central station engineer has generally quite enough to do without trying experiments, and if he errs, it is likely to be on the safe side; but this is rather a recommendation than the reverse, from a ratepayer's point of view.

Further, an engineer who has used one system, and has had a rather unfortunate experience with it, possibly owing to circumstances over which he may not have had full control, takes care to adopt any other but that system when next he has to decide, on the chance that another system could not give more trouble, and might readily give less.

Thus we find every reason why there are likely to be as many different opinions about systems as there are engineers, and even more, because it may happen that an engineer may advocate one system to-day and another a short time hence.

In the last year or two it has become much more general with regard to the generating plant to accept the tender, which, in the opinion of the engineer, offers the best value for the money, and not that which happens to be the lowest in price.

This has been found to be much the wisest course to pursue, since it is so very essential that a thoroughly reliable plant should be installed if the supply of electric energy is to be a profitable undertaking.

It is to be very much regretted that this policy has not been more universal, and especially so with regard to the distributing plant, for it seems to be more general to accept the lowest priced tender for cables, &c., whatever may be the policy adopted with regard to the generating plant.

If, however, we carefully consider this policy, it is very evident that the distributing plant, including as it does everything from the switchboard at the generating station to the fuses in the consumer's premises, should be the very best procurable.

1. In the case of the generating plant there is always, or ought to be, a reserve, whereas the same cannot be said of the distributing plant.

2. The generating plant is always under observation while working, and an incipient fault can very often be rectified before it has time to occasion harm, the reverse is the case with the distributing plant.

3. The generating plant is in a dry place, whereas a great deal of the distributing plant is buried in the ground.

4. The facilities for inspecting and testing the generating plant are vastly greater than they are for inspecting and testing the distributing plant.

5. If a fault occurs in the generating plant it is at once apparent what is wrong and steps can be immediately taken to put it right,

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* Read Friday July 2nd, 1897.

whereas in the case of a fault in the distributing plant, it very frequently takes several hours to find out what is wrong, the more especially if faults are not of frequent occurrence.

Any one of these considerations would appear to be a sufficient reason for the advisability of having the very best distributing plant procurable; how much more does the combination of them point to the same course.

The methods of distributing electrical energy, as at present used in this country, may be divided up under three headings:—

1. Low tension.—Direct.
2. High tension.—Direct.
3. High tension.—Alternating.

It may be fairly assumed that no engineer will use high tension if he can use low tension, merely for the sake of having it, for whatever pressure the current is generated at, we are compelled to supply it at low tension, and the use of high pressure is only to convey the energy a considerable distance without abnormal loss or excessive expenditure in copper.

Low Tension, Direct.—Now that the Board of Trade have raised the limit of pressure for a low tension direct current supply, there is little doubt that this system will be more generally adopted, especially on account of its suitability for tramway work, which is now coming so much to the fore.

The advantages of this system are very great; being able to drive motors and charge accumulators is of immense importance, and especially is this felt by engineers in charge of alternating stations where they can do neither directly.

These advantages are being more appreciated now that it is admitted by all how extremely important it is that the load factor of our stations should be improved and how cheaply current can be generated after the standing-by charges have been covered, and therefore how important it is that a system should be adopted which facilitates the improvement of the load factor and thereby decreases the cost of productson.

It shows how even now the full importance of a good load factor is not fully appreciated when we consider that though a great many figures are published with regard to the costs of generating electric energy and records of all kinds are being made, that no list as far as the author is aware, is published of load factors, nor is any account taken of them when comparing the costs of the various stations one with another; though a careful study of Mr. Wright's paper at the last Convention will show that a good load factor is a much more important factor in reducing the costs than the total amount of current sold which is often mentioned.

However, anyone interested in the subject can easily calculate the selling load factors of the various stations from the figures published.

With the low tension direct system there is, of course, more expensive switching apparatus at the generation station, but beyond that it is very simple; there are no transformers to break down, no risk of injury to men by coming in contact with the high tension current, &c.

The greatest trouble is keeping the pressure at the consumer's terminals anything like constant, but this will be materially lessened with the higher voltage now permitted, and higher voltage lamps.

High Tension, Direct.—This system promises to be a very useful method of reaching certain outlying areas, which may be beyond the reach of a low tension direct supply. Of course, the objection to the system is that of having moving machinery in sub-stations where there is no attendant. These rotary transformers, however, seem to give very little trouble, much less, in fact, than might be supposed.

It is a system, however, which is not applicable to a large sparsely lighted area, since in that case the low tension mains would be a very expensive item if the drop when the lights are being supplied from the batteries is not to be abnormal.

It would seem that this system is very suitable for a fairly compact area when the generating station has to be some distance from the centre of that area.

High Tension, Alternating.—This system, which presumably will not be used, except in places where the lights are so scattered that a low tension direct system would not answer, is a great boon, for without it many places which are now enjoying the advantages of the electric light would still be in darkness, and as there are a very large number of these places it naturally follows that this system is very frequently used, and it will be well to consider this system somewhat carefully, because the disadvantages which belong to it are considerable.

The only system in use in this country is the single phase, and the author only refers to that one.

At present, at any rate, there is no alternating current single-phase motor which is satisfactory for ordinary stopping and starting. The author has unfortunately found this to be so because he is frequently being asked for them and cannot recommend one that will do.

This circumstance, coupled with the fact that batteries cannot be used directly with this system, cause the load factor on many of the alternating stations to be so poor, or perhaps we ought to say the selling load factor, viz., the average amount sold as a percentage of the maximum load.

Still, however, the extreme flexibility of this system is of paramount benefit, especially in exploiting a new district.

There are three stages, if we may call them so, in this system:—

1. In a very scattered district where house transformers are used.
2. Where street transformers are used to supply a low tension network.
3. Where motor-transformer sub-stations with batteries are used.

This last stage promises to be a means of supplying the trams and larger consumers, and the demand for current suitable for use with motors.

The batteries can be charged at times of light load, and thus the load factor of the station can be made very much better.

In the case of very large consumers, sub-stations can be placed on their premises, if they will agree to take the current for a term of years. This would be especially useful in the case of theatres where a very considerable number of lights are frequently switched off and on suddenly, and thus make regulation difficult on the mains.

With regard to the house transformers, those engineers who have had them will know they are not to be desired, and it does not seem to be the correct idea that when current is supplied at a specified pressure, that it should be supplied at another pressure, and rent charged for the apparatus used to reduce it, and no doubt this system will be only used for pioneering.

With regard to the second phase, the transformers, which can now be obtained to place direct in the ground, seem everything to be desired, and this system has many advantages over the transformer chambers, as they are called, where there is too often the minimum of space with the maximum amount of danger; and switch gear is too often used which would not be tolerated at the central station, where it is in a dry place, and where there is plenty of supervision; but which, for some occult reason, is deemed good enough to put into what is liable to be a damp hole, and where there is no supervision. It will be found that most of the fatal accidents have taken place in these chambers.

If it is necessary to use sub-stations, let them be such as are used by the London Electric Supply Corporation, at Trafalgar Square and the Grosvenor Gallery, where there is plenty of room, and where there is proper switch gear and attendance.

It seems to the author that the transformers placed direct into the ground are much safer than the chambers; there is no fear of damp or gas accumulating, both are not unfrequently found in the chambers, and with properly designed switch boxes, care being taken that the very best are obtained, there is every convenience and safety.

The extreme flexibility of this system is wonderful, a transformer tank can be used which will contain a 30 kilowatt transformer and only a 15 kilowatt used at first. If the load increases the 15 is just lifted out and a 30 put in instead.

If a low tension main becomes too heavily loaded, the high pressure main can be cut and a transformer put in to feed that part. Nothing can be simpler or safer, and less expensive, as money is only expended just when and where it is needed.

This system with its three stages, seems, therefore, likely to be very extensively used, but owing to the fact that batteries cannot be used directly with it, and that it does not lend itself to the use of motors directly, the selling load factors of stations with this system are likely, when first put down, not to be very good, and therefore the cost of producing the current will not improbably be high. Of course there are sure to be some exceptions caused by special circumstances; but then it must be remembered that in many districts where this system is in use, no other system would have answered as well, so it was this or none.

It seems probable that the use of battery sub-stations will increase in the future, and then the selling load factor will be improved.

The fact that some engineers use a small motor alternator with batteries, shows how anxious they are to increase the load factor, and even use a system of this sort, when the loss must be very high.

This brings us to consider the loss in distribution of the various systems.

This is very hard to arrive at, since it is very difficult to obtain reliable figures on this point; engineers cannot, or do not, care to give accurate figures; but let us assume as, somewhere near the mark, that the losses with a low tension direct current system are 10 to 15 per cent., those with a high tension direct current system 25 to 50 per cent., and those with an alternating high pressure system and with street transformers or sub-stations, are 20 to 25 per cent., and if house transformers are used, from 25 to 50 per cent.

The question now to consider is how much this current which is lost costs to produce.

In the case of the low tension direct current system, this loss will be in the batteries, if there are any, and in the mains; this latter loss will be on for only a short time, being at the period of heavy load, and may amount to, say, 20 per cent. at that time; this means that the greatest loss occurs at the time when it costs most to generate current, and that 20 per cent. more plant has to be installed to overcome this, and a corresponding amount of interest and redemption incurred.

With a high tension direct current system, the loss, though in the aggregate greater, will not occur to so great an extent at the period of maximum load, because at that time the transformers are in use, and there will not be so much loss on the mains; a great part of the loss will occur in the batteries and low tension mains when the batteries are supplying the current, therefore it is possible and even probable that the lost energy in this case does not cost so much to produce as it does in the former case.

With a high tension alternating system, the loss will be about a constant, but the per centage will vary inversely as the load. This loss may be taken as 2 per cent. of the capacity of the transformers installed if they are of a modern type and of a reasonably large size.

This loss is probably an iron loss at the times of light load and copper loss at the times of heavy load, and is a constant factor; therefore the percentage loss will be very high when the load factor is very poor. The cost of this energy so lost will, however, be small, seeing that so large a proportion is lost during the hours of light load, when it costs very little to generate current.

Moreover, the extra plant required to be installed to overcome this loss will be only 2 per cent., and therefore the extra interest and redemption will be very small as the percentage loss becomes less as the load factor improves. It will be seen how very important it is,

where a high tension alternating system is used, that everything should be done to induce consumers to burn their lights for a long time during the day. Though this is important on every system, it is much more so in this system, which has the disadvantages already referred to.

There is one high tension alternating system, where, according to published figures, some 97½ per cent. of the current generated is sold. This almost seems too good to be true.

We now come to that very vexed question, *i.e.*, the mains required to convey the current, and if any part of the system should be the very best procurable, these certainly should be. We may divide these up into three classes:—

1. Bare conductors in conduits.
2. Insulated conductors in ducts.
3. Insulated conductors solid.

The first is in many ways the ideal system, but the opportunities that it affords for accumulations of gas and water are, of course, its great drawback.

It is generally used where large conductors are needed, but at Norwich, where ordinary sanitary drain pipes are used to form the culvert, it is used for quite small sections of conductors, and the author is informed that the price compares favourably with any other system of laying cables. Certainly the gas accumulations seem to be the greatest drawback to this system, which, if adopted, should undoubtedly admit of the insulators being readily examined.

The second system can be carried out in various ways. Cast-iron pipes, stoneware casing, and Callender bitumen troughing being the most general. Prices doubtless differ in various parts of the country, but from recent experience in the North of England the author finds that for one duct or two ducts cast-iron pipes are much cheaper than stoneware casing, and where three ducts are required the price is exactly the same. This is if the stoneware casing is laid with the cheapest kind of joint, for if it is laid with a better kind of joint, the expense is, of course, increased. There is no need to mention the many points in which cast-iron pipes seem to the author, at any rate, superior to stoneware casing, setting aside the question of price.

The best known methods of laying cables on the solid system are the armoured cables laid direct in the ground, and unarmoured cables laid in a trough and run up solid.

It is not the intention of the author to draw comparisons between the various kinds of cables, &c. He has laid almost every kind, and has been fortunate in not having experienced the wonderful faults that are so often reported. He has found that a cable, however good, may be irretrievably damaged by being badly laid and badly handled, and many of the faults which are put down to faulty manufacture are really due to bad laying. Gentlemen who have not had much experience in cable laying seem generally to think that anybody can lay a cable. Everyone who has had a wide experience, however, knows that this is a very erroneous idea, and a good cable badly laid may be worse than a bad cable well laid.

The author has avoided mentioning anything about prices because they are so uncertain, especially when there is sometimes 100 per cent. difference in the tenders sent in for such a simple thing as laying a 3-inch cast-iron pipe.

In conclusion, he would suggest that there are three states of the mind—disbelief, conviction, and that vast interval between the two which is not belief but suspense of judgment, and he ventures to think that suspense of judgment is very advisable when the various reports about faults and breakdowns are heard, and that engineers would do well not to make up their minds until the full circumstances of the case are known; if this is done, there will be less liability to condemn material which may not have been so bad after all.

THE LIGHTING OF THE EMBANKMENT.

The following further report was submitted by the Highways Committee at Tuesday's meeting of the London County Council:—On July 13th the Council authorised us to take all necessary measures for establishing, at a cost not exceeding £22,000, the electric lighting installation authorised by the Council's General Powers Act, 1893, for the Victoria Embankment and the Waterloo and Westminster Bridges; but the Council, at the same time, directed us to report further as to the details of the proposed installation. We understand that when our proposal was before the Council a suggestion was made that the generating station should be placed on the south side of the Thames instead of on the Victoria Embankment, as proposed. As regards this suggestion, we may point out that the site of the station is fixed by Section 20 of the Act of 1893 above referred to, which provides that the Council may erect, maintain and use such works, buildings and appliances as it may find convenient, on or under any part of the land bounded on the west by the Charing Cross railway bridge, on the south by the carriage-way of the Embankment, on the east by Waterloo Bridge, and on the north by an imaginary line drawn along the centre of the garden from its eastern end, near Waterloo Bridge, to its western end, near Charing Cross railway bridge. The Council would therefore have no power, without the further sanction of Parliament, to establish the station at any other place than that indicated. Under the scheme proposed by us, a subway will be constructed from the coal store of the station to the store-yard under the Charing Cross railway bridge, and, by this means, coal can be stored in the yard under cover and transferred to the station, without any interference with the traffic on the Embankment or any inconvenience to the public.

It is, moreover, anticipated that if at any future time the Council should decide to light any or all of its subways by electricity, and so avoid the use in the subways of safety lamps, which are at times a a source of trouble, the machinery to be provided at the station would be sufficient to supply the necessary current.

It is intended to put in three units, each consisting of an engine and dynamo, and each capable of supplying current to three of the six circuits intended to supply the total number of lamps. Thus up to midnight two machines would be running and one held in reserve, while after midnight one machine would be able to take the load until daybreak; this arrangement insuring that the machines shall be always running at full load, which we are informed is the most economical plan.

Our proposal for the distribution of the 90 lamps provided for in the scheme is that 27 shall be placed on the kerb on the land side and 27 on the kerb on the river side of the Embankment, 6 on Waterloo Bridge, 11 on Westminster Bridge and its approaches, 8 on the Piers adjacent to the Embankment, and the others at Northumberland Avenue approach, the entrance to the generating station, and some other points which cannot at present be determined. We are informed that it is probable that at no distant date, owing to the growth of the trees on the Embankment, it will be necessary to remove about half of them, and in that event the blocking of the light from the lamps by the foliage will be minimised. It is not proposed to interfere in any way with the parapet lamps, it being considered that the lighting from the sides of the kerbs will be sufficient.

We hope that the further information above given, supplementary as it is to that given in our report considered by the Council on July 13th, will be satisfactory to the Council.

It may be found advantageous that the work of laying the mains, and, perhaps, some of the other work connected with the installation, should, having regard to the fact that the carriageway is under the direct control of the Council, be carried out by men in the direct employ of the Council; but as to this matter we are not at present able to express a decided opinion. The erection of the generating station and the supply of the necessary machinery and plant should, we think, be the subject of contracts. It does not appear probable that the whole system can be completed by the ensuing winter, as the work of erecting the station and the laying of the mains, &c., will necessarily occupy some considerable time; but, having regard to the importance of the matter, we think that every effort should be made to ensure that the generating station shall be erected without unavoidable delay, and that at least some portion of the installation shall, if possible, be in operation by the end of this, or the early part of next, year. We therefore recommend—That the Highways Committee be authorised to invite tenders by public advertisement for the erection of the generating station and for the supply of the necessary machinery, mains, lamp standards, and other plant for the electric light installation for the Victoria Embankment and the Westminster and Waterloo Bridges, authorised by the Council's General Powers Act, 1893.

THE PRODUCTION OF STEAM.

The papers of Messrs. Snell and Steinitz, read before the Municipal Electrical Association, gave rise to very little discussion, and that not of a very high class. Mr. Crompton claimed that in a London station last winter a water tube boiler evaporated 20,000 gallons of water (per hour) throughout the night. He fortunately spared us all details as to size, so that his claim need not necessarily be questioned. A few words from Mr. Gibbings asking that boilers should be adapted to their environment were followed by Mr. Raworth, who claimed to remember, or at least seemed to do, the pre-economiser days. Now Mr. Raworth is not so old as that. He admired the writers of the paper for pushing water tube boilers in Manchester, because Manchester was built on the Lancashire boiler. If water tube boilers are anywhere a success they should be in Manchester. On Manchester town water they might work for ever without scaling, it is so perfectly soft coming as it does off almost bare grit in Longdendale. But what is good for water tube boilers is also good for Lancashire boilers and economisers, and Manchester will listen—perhaps politely—but will not readily budge. Mr. Raworth very properly doubted the propriety of a boiler maker being asked to guarantee evaporation, when he is after all only a maker to a very close specifiation.

Mr. Arnot, of Glasgow, like many other Glasgow people who boast of Glasgow water, stated they had water tube boilers in Glasgow with tubes only 1⅛in. diameter, and probably Glasgow alone could put up with this because of the water. Mr. Arnot ought to know that Glasgow has not the monopoly of soft water. What is the meaning of the trouble with lead poisoning in so many north country towns if Glasgow has such a monopoly?

Mr. Norbury, of Messrs. Galloways, as a maker of Lancashire and Galloway boilers, naturally spoke up for shell boilers. Though also makers of a water-tube boiler inferior to no other water-tube boiler, this boiler could not compare with Lancashire or Galloway boilers in efficiency, and there were fewer water-tube boilers now making for Lancashire to-day, than was the case two years ago. Mr. Norbury evidently looked on the meeting as having gleaned its boiler knowledge from the bookshelf rather than from the shovel end of steam practice.

Mr. Kolle, of the Babcock and Wilcox Company, plumped for the water-tube boiler, of course, and did not think the short life of these was anything serious, as the tubes could so easily be changed. Possibly they can easily be changed and easily charged for, but what of the constant cost?

Mr. Crosland doubted the economy of 25 per cent. with mechanical stoking. A few remarks were made anent the loss due to uncovered pipes, and Mr. Hammond remarked that at Leeds they had saved money by abolishing the ring main and saving its radiation losses. Instead, they had a main that would not break down. Mr. Wordingham objected to such practice as unjustifiable. The enormous expense which we see incurred in duplicate steam mains always seems to be open to such criticism as that of Mr. Hammond's. As we write this and look back to the days of 30 lbs. steam and any sort of cast-iron steam pipe, and bring our memory forward through a period of rising pressures and improved construction, we do not seem to see where the expense of a ring main can be justified in any reading of the doctrine of chances. To put a part of the extra cost of double mains into a main that will not break down, and save the rest for some better purpose, would seem to be sound practice, the chairman to the contrary. If any sort of duplicate main is needed, had it not best be in the division of the main into two of smaller size, using both, and risking the breakdown of one-half, which would simply overwork during repairs the other half. We confess that breakage of steam mains is not a matter to be treated more seriously than that of a second shell on a shell boiler. The general question of duplication strongly suggests whether electrical works cannot be designed more on the basis of undertakings that are not expected to break down at any moment.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

15,906. "A new and improved apparatus for writing and drawing by telegraphy." H. C. Braun. Dated July 5th.

15,933. "Combined electric battery and head light." W. Mills. Dated July 5th. (*Complete.*)

15,939. "Improvements in the manufacture of protective coverings or envelopes for zinc plates of electric batteries, and for other purposes." E. A. Jahncke. Dated July 5th.

15,940. "An improved liquid-tight trough or receptacle for use in connection with electric batteries, and for other purposes." E. A. Jahncke. Dated July 5th.

15,941. "Improvements in or connected with electric batteries." E. A. Jahncke. Dated July 5th.

15,982. "Improvements relating to telephone transmitters and receivers, and like apparatus." J. Waldthusen. Dated July 5th.

15,993. "Improvements in or relating to electric lighting." C. E. Sohn. Dated July 6th.

16,007. "Improvements in or connected with electrical ceiling roses." F. J. Borland and E. Moorhouse. Dated July 6th.

16,044. "Improvements in and relating to telegraphy." O. R. Robertson. Dated July 6th.

16,054. "Improvements in electric controllers." The British Thomson-Houston Company, Limited. (A. F. Macdonald, United States). Dated July 6th. (*Complete*).

16,065. "Improvements in incandescant electric lamps." F. Gabriel and Angenault. Dated July 6th.

16,068. "Improvements relating to the construction of rails for electric railways and to bonds therefor." S. H. Harrington. Dated July 6th. (*Complete*).

16,069. "Improvements in electric batteries." L. W. Pullen. Dated July 5th. (*Complete*).

16,073. "Improvements in safety switch apparatus for systems of electrical distribution." C. A. G. Gallice. Dated July 6th. (*Complete*).

16,092. "Improvements relating to electric lamps for cycles." T. G. Howden. Dated July 6th.

16,108. "Improved means of intercommunication by telephone." J. J. Mann. Dated July 7th.

16.134. "Incandescent electric light decorations." A. A. Pollock. Dated July 7th.

16,139. "Method and apparatus for electrical signalling by means of split or divided currents, more particularly applicable to cable transmission." C. D. Abel. (La Société Industrielle des Telephones Constructions Electriques Caoutchoucs Cables, France.) Dated July 7th.

16,220. "Improvements in electrically illuminated signs, advertising mediums, or the like." W. T. Bell. Dated July 8th.

16,225. "Improvements in or connected with telephones." J. E. O. Kumberg, B. F. Krantz, and C. M. Stewart. Dated July 8th.

16,255. "Improvements in apparatus for administering mist or vapour and electric baths for internal purification, and for ventilating, heating, and cooling purposes." C. Junge. (N. A. Renstrom, United States.) Dated July 9th. (*Complete.*)

16,259. "Automatic distribution of gas and electricity." Viscount E. P. de Fouquier. Dated July 9th.

16,276. "An improved magnetic toy." J. S. Beeman. Dated July 9th.

16,279. "Improvements in electro-magnetic and dynamo-electric apparatus." R. Wood. Dated July 9th.

16,304. "Improvements in electrical tumbler switches." H. C Gover and C. F. Proctor. Dated July 9th. (*Complete*).

16,325. "Improvements in submarine cables." S. Z. de Ferranti. Dated July 10th.

16,339. "Improvement in dynamo-electric machine." G. C James and H. P. Ward. Dated July 10th.

16,350. "Improved coil for electric instruments. W. Thomson and Baron Kelvin. Dated July 10th.

16,361. "Improvements in or relating to accumulator plates for secondary batteries." E. W. Jungner. Dated July 10th. (*Complete*).

16,362. "Improvements in or relating to the electrodes of electric accumulators." E. W. Jungner. Dated July 10th.

16,405. "Improvements relating to electric telegraphy." O. J. Lodge and A. Muirhead. Dated July 10th.

16,407. "Improvements in incandescent electric lighting systems." C. Ormsby. Dated July 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 8½*d.* (*in stamps*).]

1896.

4,996. "Improvements in jointing boxes for conduits carrying electrical conductors." F. Bathurst. Dated March 5th. The invention consists in providing the box with a number of outlets with a stud, to which the insulating base of the fittings is fixed with suitable connections. The box has an insulated lining, and is provided with a cover. 4 claims.

7,166. "Improvements in electric fire alarms." M. A. Shanahan. Dated April 1st. A bolt is held in position by a fusible plug, a cap mounted above with a tubular extension, through which pass two wires connected to binding posts. When the fusible plug melts, the bolt is forced against the binding posts by means of a powerful spring completing the circuit to operate a bell or other indicating device. 3 claims.

15,488. "A new or improved electric furnace." F. H. Haberlein. A. Holloway, J. B. Collier and W. H. Murch. Dated July 13th, The invention relates to furnaces used more especially for the production of aluminium and the manufacture of calcium carbide. The pot containing the material under treatment is surrounded by an ordinary furnace or with furnace flue. The calorific effect of the fuel is thus employed direct, and but a small portion has to be converted into electrical energy. The electric current may be switched on, and the two heating methods caused to act concurrently. The outside heating may be produced either by solid, liquid or gaseous fuel. 6 claims.

24,554. "An improved way of connecting electrical fittings." R. C. Jehault. Dated November 3rd, 1896. The invention consists of having two metal terminals mounted on an insulating plate to which are connected respectively the wires from the fittings and the wires from the mains. 1 claim.

25,804. "Improvements in the electrolytic production of zinc and alkalies." Dr. Otto Dieffeubach. The invention relates to the electrolytic production of zinc together with soda or potash, from the corresponding sulphates, by means of an electrolytic decomposing apparatus that is divided by two diaphragms into three compartments, in the cathode space of which metallic zinc is separated from an alkaline zinc solution, such process consisting in the simultaneous production of free sulphuric acid from the sulphate solution contained in the anode space and free alkali from the sulphate solution in the middle space, the alkali being obtained in a pure condition by the regular renewal of the lye enriched up to a certain degree, and by the separation of the sulphate salts by evaporation. 3 claims.